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UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *February*, 1892.

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OF THE

UNITED STATES GEOLOGICAL SURVEY

VOLUME XVII

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1892

UNITED STATES GEOLOGICAL SURVEY

J. W. POWELL, DIRECTOR

THE FLORA

OF THE

DAKOTA GROUP

A POSTHUMOUS WORK

BY

LEO LESQUEREUX

EDITED BY F. H. KNOWLTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1891

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
U. S. GEOLOGICAL SURVEY,
DIVISION OF PALEOBOTANY,
Washington, D. C., December 11, 1890.

SIR: I have the honor to transmit herewith the manuscript and drawings of a monograph of the flora of the Dakota Group, by Prof. Leo Lesquereux, edited by Prof. F. H. Knowlton, and to request its publication.

Very respectfully, your obedient servant,

LESTER F. WARD,
Geologist in charge.

Hon. J. W. POWELL,
Director.

EDITOR'S PREFACE.

This volume upon the flora of the Dakota Group was the last work upon which Prof. Lesquereux was engaged. He had already in his Cretaceous Flora[1] and the Cretaceous and Tertiary Floras[2] made extensive contributions to the knowledge of Dakota Group plants, but by the discovery of rich plant deposits in central and western Kansas, in Nebraska, Minnesota, and other places, much additional material was obtained. This material had been collected from time to time until about 1885, when he set to work to prepare a final monograph. The manuscript of this monograph, which filled about 475 written pages and was accompanied by 45 quarto plates, was completed and sent to the Director of the U. S. Geological Survey on February 21, 1888. It embraced descriptions and figures of 350 species of plants.

A few months after it had been sent to Washington, and before it could be taken up for publication, very extensive additional collections were made in Ellsworth County, Kansas, by Mr. Charles H. Sternberg, and by the Museum of the University of Kansas, under the direction of Prof. F. H. Snow. This material, which numbered some thousands of specimens, was sent to Prof. Lesquereux for identification, and, although he was in feeble health at the time and knew full well that his days for work must necessarily be numbered, he entered upon the task with characteristic enthusiasm. He saw at once that the material contained much that was new and interesting, and in order that it might be incorporated in the monograph he asked that the manuscript and plates be returned to him. This was done, and his last days were spent in working up and adding this new matter, and at the time of his death the material had all been identified and described and most of

[1] Contributions of the Fossil Flora of the Western Territories. Part I: The Cretaceous Flora, U. S. Geol. Survey of Terr., Vol. 6, Washington, 1874.

[2] Contributions to the Fossil Flora of the Western Territories. Part III: The Cretaceous and Tertiary Floras. U. S. Geol. Survey of Terr., Vol. 8, Washington, 1883.

it figured. The value of this new material will be appreciated when it is known that it added 110 species to the already rich flora of the Dakota Group. This brings the total number of known species from the Dakota Group up to 460.

The task of the editor of a posthumous work is always a delicate one, especially when any portion of such a work is left unfinished, for he is in constant fear that he may not correctly interpret and carry out the wishes of the author. I have, therefore, made hardly any changes, except those expressly implied or called for in the notes left by Prof. Lesquereux himself. As he worked upon this later, and in some respects richer material, certain previous conclusions of his underwent modification; thus, additional material led him to change what had first been described as *Phyllites Masoni* to *Ilex Masoni*, *Phyllites cretaceus* to *Platanus cretacea*, etc. Changes of this kind were not actually made by himself, but were indicated by notes. Additional points of comparison among the species were also suggested as his work went on, and whenever indicated they have been carefully attended to.

The only specimens that had not been figured at the time of Lesquereux's death were purchased of Mr. Sternberg, together with many others, by Mr. R. D. Lacoe, of Pittston, Pennsylvania. These Mr. Lacoe has courteously placed at our disposal, and they have been drawn by Mr. F. Von Dachenhausen, the artist of the Paleobotanical Division. They number 30 figures, and fill Plates LXIV, LXV, LXVI.

In a few instances the specific names given by Prof. Lesquereux to new species were preoccupied; for example, "*Celastrophyllum obovatum*, sp. nov.," is antedated by *C. obovatum* of Fontaine; "*Myrica proxima*, sp. nov.," by the *M. proxima* of Ettingshausen, etc. Such names I have changed, and have indicated the fact in foot-notes.

I have also changed the arrangement of some of the orders and genera to make it conform to that in Bentham and Hooker's Genera Plantarum, or rather have arranged them in the reverse order of this, since they proceed from the lower to the higher plants.

In conclusion, I beg to acknowledge my great obligation to Prof. Lester F. Ward, for counsel and valuable assistance; to Mr. C. D. White, who has verified all of the references; to Prof. F. H. Snow, of the University of Kansas, who has supplied information that was lacking, and a valuable series of specimens; and especially to Mr. R. D. Lacoe, of Pittston, Pennsylvania, who has generously placed his extensive and highly valuable collection of Dakota Group plants entirely at my disposal. I am also under obligation to numerous collectors and students throughout the country who have, by contributing either specimens or valuable information, combined to make the flora of the Dakota Group one of the most thoroughly known fossil floras of the world.

I take this opportunity of appending here a short account of Prof. Lesquereux's life and work.

LEO LESQUEREUX.

Leo Lesquereux, the Nestor of American paleobotanists, died at his home in Columbus, Ohio, October 25, 1889. His life, while exceedingly varied and filled with hardships and disappointments, was a singularly pure and noble one, and America lost by his death not only her most distinguished vegetable paleontologist, but her foremost bryologist, and the few who enjoyed the honor of his personal acquaintance lost a genial companion, a kindly critic, and a sympathetic friend. He was the last of the distinguished trio—Agassiz, Guyot, Lesquereux—which the Geneva Revolutionary Council of 1848 by its edict suppressing the Academy of Neuchâtel sent to our shores. These men, "born in the heart of Switzerland's mountain grandeur," early imbibed that love of nature which was ever the actuating impulse of their lives. The departments of science which they so assiduously studied would be comparatively incomplete but for their untiring efforts.

Lesquereux was an exceedingly modest and retiring man. The early misfortune of the loss of his hearing made communication and intercourse so difficult that he rarely ventured from home, and those who knew him best knew him only through the medium of correspondence. As he once said: "My associations have been almost all of a scientific nature. I have lived with Nature, the rocks, the trees, the flowers. They know me; I know them. All outside are dead to me." But in spite of this drawback and of the changes that it necessitated in his life he bore it cheerfully and uncomplainingly.

Several excellent accounts of Lesquereux's life have appeared, written by personal friends and companions, but by the courtesy of Prof. Lester F. Ward I am able to reproduce here a short autobiographic letter, written in response to a request, in which the chief incidents of his life are related in his own modest, quaint language:

COLUMBUS, OHIO, *May* 1, 1884.

Prof. LESTER F. WARD,
Washington, D. C.:

MY DEAR SIR: I am greatly honored by your kind letter of the 29th past, and hasten to answer it. Indeed, I have wanted for some weeks to write to you and have only been prevented from doing so by a somewhat long spell of sickness. I will, however, write to you as soon as I have a moment of leisure. I am now crowded with proofs coming in mass for correction, and can but now say only what you wish to know.

I was born at Fleurier, Canton of Neuchâtel, Switzerland, November 18, 1806. My father was a manufacturer of watch springs, in tolerably good circumstances, but not rich. Being the only son, and fond of books, especially of rocks and flowers, a kind of *natural*, as they call people of that kind in the South, my mother wanted me to become a minister. My family, Lescure, Lescurieux, Lesquereux, being of French origin, Huguenots, emigrated from France, with most of the old families of French Switzerland. To that end, after my village schooling, I was sent to college at Neuchâtel, and there passed through all the classes up to the last one (philosophy), being then ready at my nineteenth year to go to the university. My father had paid at Neuchâtel my board only. I had earned the expenses of academical lessons by teaching. My father being unable to support expenses at the university in Germany, I accepted a position in Saxony at Eisenach as professor of French language, expecting to make money enough to go later to a university. But after four years' sojourn at Eisenach I became engaged to a young lady, and instead of going to the university I came back to Switzerland and was accepted as principal of a college, La Chaux de Fonds, and after one year went back to Eisenach to get married. After three years of teaching at La Chaux de Fonds I became gradually and soon totally deaf, or at least so deaf that I had to abandon my position and find something else to support my family. I did that for years by manual labor, having returned to my family and gone in partnership with my father. But I could not stick to that work, and was constantly busy in my hours of rest, that is mostly in the night, with a poor, small microscope, studying mosses, and on Sundays running in the mountains to gather them. The Government of Neuchâtel was then greatly interested in the protection of peat bogs on account of the difficulties of procuring fuel for the poor, and offered a prize (gold medal of 20 ducats) for the best memoir on the formation of the peat, its preservation, etc. I went to that study and won the prize. My memoir—Recherches sur les Tourbières du Jura—is still quoted and has been long considered as the best on the subject. It was from the publication of that memoir that I become more intimately acquainted with Agassiz, and that the King of Prussia (that is his Government), offered to pay my expenses and somewhat more if I would undertake a tour of exploration through Germany and any other countries I should wish in Europe, for the investigation of the peat bogs. Of course I accepted, went through Germany, Sweden, Denmark, Holland, Belgium, France, everywhere I could find peat bogs, and returned with a mass of material which I expected to use for a book on the subject. Neuchâtel was then under the protectorate of the King of Prussia. In 1848, and when I was engaged as director of exploitations of peat bogs bought by the Government, the liberal or Swiss party became master of the situation and all those who had been appointed to any place by the Government were of course thrown aside. The Academy of Neuchâtel was also broken up. Agassiz was already in America one year before. He encouraged the professors to come to America, Guyot, Matile, and others, myself, too. And as the future prospects for the support of my family were gloomy, my father, too, encouraging me to come here, I embarked, with my wife and five children, as steerage passengers, and arrived at Boston in September, 1848. That is about all. That, fighting against odds, especially by my total deafness, I have had plenty of hard times, is easily understood. But all has been well for me, thanks to a kind Providence.

About the publications of mine, you have probably more titles than I know of, for I have forgotten many and many are not worth much. I am now reading the proof of a third volume of the United States Coal Flora; of a Synopsis of the American Mosses, and of a small book—Principles of Vegetable Paleontology—for the Geological Survey of Indiana. After that I think to close my active career, if I can possibly do that; for I must work for my living.

Excuse this long talk. It is your fault. If you want an old man to say one word on himself he will make quite a discourse.

Sincerely yours,

L. Lesquereux.

Lesquereux was therefore over 40 years of age when he reached this country. He was totally deaf and had never heard a word of spoken English in his life, yet he set bravely to work in winning a home. His first work in this country was done for Prof. Agassiz. This consisted in working up and preparing for publication the collection of plants made by Agassiz on his Lake Superior expedition. His report was published in 1848.

At the close of the same year he was called to Columbus, where he made his home for the remainder of his life. The circumstances under which he came to Columbus deserve to be mentioned, as they bring to light a history that has few counterparts in the country hitherto. By the publication in 1845 of the *Musci Alleghaniensis*, Mr. William S. Sullivant, of Columbus, had put himself at the head of American bryologists, and was so recognized at home and abroad, the scientific collections of the Government in this Department even coming into his hands for study, and the field was in every way widening before him, bringing him more than he could do unaided. He was a gentleman of large fortune and was therefore not obliged to ask even a living from science. All of his work was done at his own charges and most of it was published in like manner. It was distributed among his fellow laborers in a like manner. Mr. Sullivant called Lesquereux to his aid, and for many years thereafter, even to the date of Mr. Sullivant's death, the foremost bryologist of America and one of the most accomplished bryologists of Europe worked side by side in completest accord and harmony with mutual respect for each other's acquirements and results. Lesquereux was employed by Mr. Sullivant one or two years and was afterward aided in various ways in carrying forward his work by the generosity of his friend.[1]

[1] Leo Lesquereux. By Edward Orton. The American Geologist, vol. 5, No. 5, May, 1890, pp. 291, 292.

Lesquereux and Sullivant published together the two editions of the Musci Exsiccati Americani, the first edition in 1856, the last in 1865. The Latin text of Sullivant's Icones Muscorum was also largely written by Lesquereux, and the publication of the second volume was carried forward after Sullivant's death.

For some years before his death, Sullivant had been engaged in collecting materials for the publication of a complete account of the North American moss flora. After his death his extensive collections and library were deposited in Harvard College Herbarium, and at the urgent request of Dr. Asa Gray, Lesquereux was prevailed upon to take up and complete the task. Much of this work was done before his sight failed him in 1869, when it was necessary to call in other assistance, and Prof. Thomas P. James, of Cambridge, was interested in the work. He made such of the microscopical examinations as had not been made, but his death again delayed the work, and it was not until 1884 that it was finally completed and given to the world as a Manual of North American Mosses.

His paleobotanical work is so extensive and valuable, and is so well known to all students of the science the world over, that little mention of it is necessary here. His first work was published in 1854, and from that year until the day of his death the world saw issuing almost every year an additional volume testifying to his indomitable energy and keen discrimination. He was a pioneer in the department of vegetable paleontology in this country, and while some of the earlier work done, as is so commonly the case in new and unworked fields, will need revision when the fossil flora of America is more thoroughly worked up, the whole stands as a monument which future generations may well marvel at and emulate.

F. H. KNOWLTON,
Assistant Paleontologist.

U. S. GEOLOGICAL SURVEY,
Washington, D. C., December 19, 1890.

THE FLORA OF THE DAKOTA GROUP.

By Leo Lesquereux.

INTRODUCTION.

The details concerning the first discovery of leaves of dicotyledonous plants in the strata of the Dakota group, the subsequent researches made by Messrs. Meek and Hayden, by Dr. J. S. Newberry, and later by Prof. Jules Marcou, Prof. J. Capellini, and Oswald Heer, as well as the evidence furnished as to the age of the formation by the distribution of animal remains in the strata superposed upon it, have all been presented with reference to the data in my monograph of The Cretaceous Flora (pp. 1–10), which forms vol. 6 of the Reports of the U. S. Geological Survey of the Territories under F. V. Hayden.[1] In the same volume there is also recorded what was then known of the geographical and stratigraphical distribution of the Dakota Group, its superposition upon the Permian, its thickness, the width of its area as recognized in Kansas, Nebraska, and Minnesota, its probable continuity westward under more recent or Tertiary formations, and the manner of deposition of the vegetable remains.

Later in the Cretaceous and Tertiary Floras, which forms vol. 8 of the Hayden Monographs,[2] record is made of the discovery of a number of specimens of fossil plants, identical with or closely allied to those of the Dakota Group of Kansas, in Cretaceous strata exposed by upheaval at the base of the Rocky Mountains of Colorado, a discovery proving the westward continuity of the formation.

I have nothing to add now to what has been published on these different subjects. A geological survey of the State of Kansas similar to that of

[1] Quoted in this volume as Cret. Fl.; ibid., Vol. 7, as Tert. Fl.

[2] Quoted in this volume as Cret. and Tert. Fl.

Minnesota, now in progress, will undoubtedly clear up much that still remains uncertain concerning the width of the area occupied by the Dakota Group in the United States, the thickness of its deposits, the composition of the strata observable at different localities, as well as the direction and degree of the dip, etc.

The present memoir is for this reason limited to the description of fossil plants represented by a large number of specimens recently obtained at different localities of the Dakota Group, especially in Kansas and, of course, to the evidence derived from the character of the plants in regard to their origin, their relations, and their places in the history of the vegetation of the world.

The significance attached to the nature of these plants is well known. They pertain to an epoch in which, by the appearance of the dicotyledons, the character of the flora of the globe has been modified as though by a new creation. The cause or reason of this marked change remains still unexplained, and can become known only by a more intimate acquaintance with the flora of that part of the Middle Cretaceous which is generally recognized as the Cenomanian period. This flora is known in Europe by remains of plants found in the Quadersandstein of the Harz, and first described by Hampe, later by Zenker, Dunker, and Stiehler, and representing twenty-five species; then by those discovered in the Cretaceous strata of Niederschöna, Saxony, from which Ettingshausen has described thirty species; then by sixteen species described by Heer from Moletein, in Moravia; by sixteen described by the same author from Quedlinburg, Prussian Saxony, and by seventy-five species from the Bohemian Cretaceous described by Velenovský. All the localities named above are far distant from each other, but have been with more or less doubt referred to the same horizon of the Middle Cretaceous, viz, the Cenomanian. Admitting the correctness of the reference, we have in all about one hundred and ten species as constituting the flora of the Cenomanian of Europe. This seems a small number indeed, for two hundred and seventy-four species have been described by Heer from the Cenomanian of Greenland, to which must now be added the plants from the Dakota Group, from which four hundred and sixty species are known.

In my Cretaceous Flora the questions concerning the probable derivation of the numerous vegetable remains found in the shaly sandstone of the Dakota Group, their mode of deposition, etc., have been examined. From the facies and the peculiar distribution of the leaves, it is there admitted that the vegetable remains had been derived from trees or shrubs growing in the vicinity of marshy or muddy bottoms, and that they have been buried and fossilized at or near the place of their growth. This conclusion is based not only upon the remarkably good state of preservation of the fossil leaves, which are generally found horizontally flattened in the same plane or parallel to that of the deposition of the earthy matter, neither crumpled, rolled, nor lacerated, and with their borders, often even their petioles attached to them, but also upon the distribution of the leaves which at different localities generally represent different species. Sometimes all the leaves of a local area belong to the one species, while at a short distance another group of leaves represent other species, genera, or even families.

These remarks have been lately fully confirmed by the discovery in Ellsworth County, Kansas, of a very large number of leaves embedded in concretions in the same manner as remains of Carboniferous plants have been preserved in the celebrated nodules of Mazon Creek, Illinois. More than three thousand specimens of this kind have been collected in that county by Judge E. P. West, assistant of Prof. F. H. Snow, of the University of Kansas, and later by Mr. Charles H. Sternberg. The concretionary specimens were found at more than twelve different localities, in groups covering limited areas, the largest tract being about 100 yards, the others not more than 20 yards in width, altogether distributed upon a land surface of 5 to 8 square miles. The specimens of each locality were separately collected and were also determined separately, and each lot was found to be composed of leaves of from one to three species, and few of them were represented in more than two or three localities. Thus, leaves of Sterculia were found at one locality, at another leaves of Grewiopsis; in two or three others, mostly small leaves of Betulites were collected, and in others leaves of *Populus kansaseana*, with *Diospyros rotundifolia*, etc. As can be seen upon the plates, the leaves forming the nucleus of the pebbles are in a perfect state of preservation, a number of them with their pedicels, with even a small stipule at their base. Of course the fossilization of numerous leaves of the same species in nodules, the distribution of different species in groups at various more or less distant localities, give positive evidence of their growth at the place, or at least quite near, where their remains have been fossilized.

As yet the relative altitudes of the localities where the various groups of specimens have been found have not been fixed, and we do not know whether the diversity of the characters of the plants might be accounted for by a difference in the horizon of the strata where they have been found and therefore by a difference of age. Are there peculiar zones in the formation which might be indicated by marked characters in the vegetation? No answer can as yet be given to the question. The concretionary specimens mentioned above have been found on the so-called highlands of Ellsworth County. But what are those highlands as compared in altitude to the lowlands? Prof. Mudge, who has closely searched for the distribution of the remains of plants in Kansas, did not find any differences in the character of the plants that seemed to depend on the altitude of the hills. He recognized leaves of the same species from the top to the bottom of wells 40 feet deep. Near Salina, at a locality mentioned in Cret. Fl., p. 30, I have found the same species of vegetable remains distributed from the base to the top of the hills, the altitude being about 75 feet above high-water mark of the river. Hence, it is not possible, as yet, to consider a difference in the vegetation by peculiar zones like those in the Quadersandstein or Middle Cretaceous of Europe, where the zones of the Liriodendron or those of the Credneria are mentioned as marking the relative horizons of the strata.

The specimens of leaves or fragments of vegetation described below have been collected by Mr. Charles H. Sternberg for the Museum of Comparative Zoology of Cambridge, Massachusetts, by Mr. J. C. Mason for the cabinet of Mr. R. D. Lacoe, of Pittston, Pennsylvania, and later by Mr. Ambrose Wellington and Judge E. P. West for the museum of the University of Kansas. Prof. F. H. Snow, of the University of Kansas, has also furnished important assistance by the communication of a number of specimens from his cabinet of all found in Kansas, and Prof. N. H. Winchell, State geologist of Minnesota, has authorized the description of a few species represented by specimens obtained by the survey of that State in the same formation. Quite recently a large collection of fossil plants of the Dakota Group, made in Kansas by Mr. Sternberg, has been added to the above.

DESCRIPTION OF SPECIES.

CRYPTOGAMIA.

FUNGI.

Order PYRENOMYCETES.

SPHÆRIA PROBLEMATICA, sp. nov.[1]

Pl. XXXI, Fig. 2, 2a.

One of the specimens of *Sterculia Snowii*, Pl. XXXI, Fig. 2, is partly covered by very distinct round or oval, even sometimes triangular dots, 0.5 to 1^{mm} in diameter. Each dot has two prominent marginal rings surrounding a small central areole (Fig. 2a, enlarged). It represents a species of Sphæria and greatly resembles *S. Braunii* Heer.[2]

SCLEROTIUM? SPECIES.

Pl. LIX, Figs. 4, 4a.

The leaf of *Macclintockia cretacea* Heer, figured on Pl. LIX, Fig. 4, shows a parasite, which is of a doubtful nature and is so obscure that it has not been specifically named. The fragment from Kansas has a line of parasites which are oval, acute at the lower part, concave, with a convex point in the middle; they are placed along the lateral nerves in a row of ten or more and by their position only are comparable to *Sclerotium cinnamomi* Heer, Fl. Foss. Arct., vol. 3, pt. 3, p. 12, Pl. I, Fig. 2, 2b.

[1] This species was described but not specifically named by Prof. Lesquereux under his description of *Sterculia Snowii* (q. v.), where he also says of it: "Though the species can not be identified the generic reference is evident." In order that it may be independently referred to I have ventured to call it *Sphæria problematica*.—F. H. K.

[2] Fl. Tert. Helv., vol. 1, p. 14, Pl. I, Figs. 2–2e.

FILICES, FERNS.

Family POLYPODIACEÆ.

Tribe PECOPTERIDEÆ.

PECOPTERIS NEBRASKANA Heer.

Saporta, Fl. Foss. de Sézanne, p. 332, Fig. 8; Lesquereux, Cret. Fl., p. 46, Pl. XXIX, Figs. 5, 5a.

Tribe PTERIDEÆ.

PTERIS DAKOTENSIS, sp. nov.

Pl. I, Figs. 2, 3.

Ultimate pinnæ linear-lanceolate, pinnately deeply cut into oblique equal subopposite lanceolate blunt-pointed and subfalcate pinnules, connate above the base, entire, close but disconnected above; median nerve thin, distinct; secondaries opposite, 6–7 pairs, simple, curving upward in passing to the borders.

This species is comparable, at least in the form and the disposition of the pinnules, to *P. Albertsii* Dunk., as figured by Heer.[1] It is, however, smaller in all its parts; the pinnules are clearly disconnected from below the middle, and the lateral veins simple.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4048 of Mr. R. D. Lacoe's collection, of Pittston, Pennsylvania.

Tribe ASPLENIEÆ.

ASPLENIUM DICKSONIANUM Heer.

Pl. I, Figs. 1, 1a.

Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 31, Pl. I, Figs. 1–5; vol. 6, 2 Abth., p. 3, Pl. II, Figs. 2, 2b; p. 33, Pl. XXXII, Figs. 1–8.

"Leaves triply pinnate; rachis firm, rigid; primary and secondary pinnæ lanceolate; pinnules narrowly lanceolate, the lower acute serrate, the upper entire, acute."

[1] Fl. Foss. Arct., vol. 6, 2 Abth., p. 29, Pl. XXVIII, Figs. 1–3.

The above is Heer's description. He adds: "The species is, by the finely cut leaves, closely allied to *Asplenium (Adiantum) nigrum* Linn., the form with smaller more sharply cut pinnæ, which Bory has separated as *A. acutum*."

The fragment of this species here figured represents merely the upper part of two pinnæ or fragments of a frond. The aspect of the plant is rigid; the lobes of the pinnules are narrow, all entire, sometimes short, like obtuse teeth, as in those figured in Heer's work.[1] The nerves of the leaflets are thin, parallel, forking above, and the rachis, of which a small part is figured enlarged. Pl. I, Fig. 1a, is very obscurely, irregularly, and thinly lined. The identity of the fragment can not be doubted.

Habitat: Ellsworth County, Kansas. No. 76 of the Museum of the University of Kansas. Collected by A. Wellington.

Tribe GLEICHENIEÆ.

Gleichenia Kurriana Heer.

Flora von Moletein, p. 6, Pl. II, Figs. 1–4; Lesquereux, Cret. Fl., p. 47, Pl. I, Figs. 5–5c.

Gleichenia Nordenskiöldi Heer.

Fl. Foss. Arct., vol. 3, pt. 2 (Kreidefl.), p. 50, Pl. IX, Figs. 6–12; Hayden's Ann. Rept., 1874, p. 334, Pl. II, Figs. 5–5a; Lesquereux, Cret. and Tert. Fl., p. 26.

Tribe LYGODIACEÆ.

Lygodium trichomanoides Lesq.

Hayden's Ann. Rept., 1874, p. 333; Cret. Fl., p. 45, Pl. I, Fig. 2; Cret. and Tert. Fl., p. 27.

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[1] Loc. cit., vol. 3, pt. 2, Pl. I, Figs. 1, 2, 3.

PHANEROGAMIA.

GYMNOSPERMÆ.

Order CYCADACEÆ.

Tribe ENCEPHALARTEÆ.

Subtribe ZAMIEÆ.

ZAMITES SPECIES.

Pl. I, Fig. 8.

Leaf coriaceous, narrowly lanceolate-acuminate, 1^{cm} broad in the lower part, where it appears broken, 8^{cm} long; nerves very close, parallel, scarcely distinct.

The fragment is comparable in its form at least to the leaves of *Z. Feneonis* Brongn., as figured and described by Schimper,[1] of which, however, the nerves are more distinct and distant and all equal. In our leaf the nerves are so thin and close that they can be counted only with a strong glass and are separated at a distance of 1^{mm} by a few more distinct ones, though also very thin. It does not appear that these last nerves are casually swelled or regularly marked as primaries, separated by thinner secondaries, as in the leaves of species of Glumaceæ, such as Cyperus, Phragmites, etc. The hard texture of the leaf, which is even coriaceous, and the very thin nervation, militate against the reference of the fragment to any glumaceous plant.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4060 of the collection of Mr. R. D. Lacoe, of Pittston, Pennsylvania.

PODOZAMITES HAYDENII Lesq.

Cret. and Tert. Fl., p. 27.

Pterophyllum? Haydenii Lesq., Hayden's Ann. Rept., 1874, p. 334; Cret. Fl., p. 49, Pl. I, Figs. 6, 6b.

PODOZAMITES OBLONGUS Lesq.

Cret. and Tert. Fl., p. 28, Pl. I, Figs. 10, 11.

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[1] Pal. Vég., vol. 2, p. 152; Atlas, Pl. LXXI, Fig. 2.

Podozamites stenopus, sp. nov.
Pl. I, Fig. 7.

Leaves coriaceous, with shining surface, short, somewhat enlarged below the middle, rounded at base to a thin, narrow, twisted obtuse pedicel; nerves thick, distant 1^{mm}, curved at base in the direction of the petiole and there dichotomous.

The fragment, nearly 4^{cm} long, 17^{mm} broad below the middle, is by its distinct and distant nerves related to *P. latipennis* Heer,[1] which, however, has the leaves longer and scarcely narrowed at the broad base or point of attachment. In form the fragment resembles *P. tenuinervis* Heer,[2] which is described as having the leaves large, oblong-oval, narrowed at base, nerves close and very thin. The last character evidently distinguishes it from the present species, which appears distinct from any other of the genus. It is also comparable to *P. Haydenii* Lesq., mentioned above, which has short obtuse leaves that are curved and only slightly attenuated at base.

Habitat: Ellsworth County, Kansas. No. 66 of the Museum of the University of Kansas; A. Wellington, collector.

Podozamites angustifolius (Eichw.) Schimp.
Pl. I, Fig. 4.

Heer, Fl. Foss. Arct., vol. 4, pt. 1, p. 36, Pl. VII, Figs. 8–11; Pl. VIII, Figs. 2e, 5; Lesquereux, Cret. and Tert. Fl., p. 28; Leth. Ross., vol. 2, p. 39, Pl. II, Fig. 7.

Leaves long and narrow, somewhat falcate or ensiform, linear-lanceolate, gradually slightly narrowed upward from the middle, blunt pointed or obtusely acuminate (point broken), narrowed in the same degree toward the base and distinctly nerved; nerves prominent.

In the fragment figured, which is 9^{mm} broad and 11^{cm} long, the nerves are ten in number in the middle of the leaf. Another fragment recently sent from Kansas, and which I refer to the same species, is only 6^{mm} broad, with twelve distinct convex nerves. The characters of these fragments agree evidently with the figure of the species in Heer,[3] representing part of a leaf of the same width, with nerves at the same distance as mentioned above (1^{mm}). The other fragments figured belong to much narrower leaves.

Habitat: South of Fort Harker, Kansas. No. 24 of the Museum of Comparative Zoology, of Cambridge, Massachusetts.

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[1] Fl. Foss. Arct., vol. 6, 2 Abth., p. 42, Pl. XIV, Figs. 1–9.
[2] Loc. cit., p. 44, Pl. XVI, Fig. 9.
[3] Loc. cit., Pl. VII, Fig. 5.

PODOZAMITES LANCEOLATUS (L. & H.) Brongn.

Pl. I, Figs. 5, 6.

Heer, Fl. Foss. Arct., vol. 4, pt. 1, Pl. VII, Figs. 1–7c, d; ibid., pt. 2, p. 106, Pl. XXIII, Figs. 1c, 4a, b, c; Pl. XXVI, Figs. 2–10; Pl. XXVII, Figs. 1–8.

Zamia lanceolata L. & H., Foss. Fl. Gt. Brit., vol. 3, Pl. CXCIV.
Zamites lanceolatus Morr., Ann. & Mag. Nat. Hist., vol. 7, 1841, p. 116.

Leaves distant, entire, narrowed at base into a short pedicel; lanceolate-acuminate, or linear-oblong, obtuse; nerves 14–30, generally 20–25; dichotomous above the base, thence simple, converging at the apex.

The two fragments which we have of this species show entire agreement with the description of it given by Heer from numerous well preserved specimens. The fragment (Fig. 5) corresponds to that in Heer[1] *(P. lanceolatus*, var. *latifolius)*, while Fig. 6 agrees with the one on the right of Fig. 3 of the same plate. The first fragment has twenty-six nerves; the second, which is much the narrower, has only twenty.

Habitat: Elkhorn Creek, near Fort Harker, Kansas. Nos. 195 and 211 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

PHYLLITES ZAMIÆFORMIS, sp. nov.

Pl. II, Fig. 7.

Leaf somewhat falcate, linear-lanceolate, deeply marked lengthwise by three strong distant striæ or ribs coming nearer together toward the point of the leaf, the spaces between the striæ being minutely lineate or nearly smooth.

The fragment is 12^{cm} long, broken at the top and the base, 1.5^{cm} broad in the middle and gradually narrowed upward to the apex, being 4^{mm} in diameter at the point where it is broken. It has a degree of likeness to leaves of Zamieæ, such as those of *Podozamites angustifolius* Eichw., but no species of this genus has the striæ so far distant and so thick. In this particular it resembles the fragment of a stem figured by Heer as *Equisetites grœnlandicus*[2] from the Lower Cretaceous of Kome, but this fragment is that of a stem, and though the ribs are at about the same distance and of the same character and the space is obscurely striate as described by Heer for his species, the fragment from Kansas is really that of a leaf, as shown by the ribs becoming gradually more approximate toward the apex. It may be

[1] Loc. cit., Pl. XXVI, Fig. 6.
[2] Fl. Foss. Arct., vol. 3, pt. 2, p. 61, Pl. XIII, Fig. 10.

compared also to *Schizoneura paradoxa* Schimp. et Moug. (Triassic), as figured by Heer,[1] a leaf which has the primary nerves or ribs much thinner than the specimen from Kansas.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4076 of the collection of Mr. R. D. Lacoe, of Pittston, Pennsylvania.

Subtribe EUENCEPHALARTEÆ.

ENCEPHALARTOS CRETACEUS, sp. nov.

Pl. I, Fig. 12.

Pinnules obovate-oblong, cuneiform at the base, round-pointed (?) at apex (broken); borders spinous-dentate; nerves thick, diverging, and dichotomous near the base, becoming gradually more distant and simple in the upper part.

This fine leaf, of which the upper part is unhappily destroyed, so clearly resembles those figured by Saporta[2] that it seems to represent the same plant.

The fragment is 9^{cm} long, 4^{cm} broad above the middle, has the sharply pointed teeth of the border more or less distant, entered by the points of the diverging nerves, which, averaging 0.5^{mm} in thickness, become in the upper part 1.5 to 2.5^{mm} distant. The figures given by the author as a portion of a frond and leaves characterize, according to him, the genus Encephalartos of the Zamieæ. Schimper describes the male and female strobiles of the genus and says of the caudex or stem that it is mostly subterranean, ovate-cylindrical, bearing traces of squamiform loricate leaves with rigid, prickly leaflets, entire, spinose, dentate or lobate on the borders, the lobes being spinous. At the present epoch the plants of this genus inhabit the austral regions of the American continent.

The fragment figured here is not the first fossil referable to the genus of the Zamieæ of our epoch. Saporta[3] mentions the discovery of a large frond of Encephalartos (*E. Gorceixianus* Sap.) found in the Miocene of Koumi, Eubœa, the fronds of which measure nearly one metre in length and with leaves 10^{cm} long. If the whole leaf of the Dakota Group specimen were preserved it would be nearly of the same size. The species of Koumi is, however, different in the borders of its leaves being entire.

Habitat: Ellsworth County, Kansas. No. 47 of the Museum of the University of Kansas. Collected by A. Wellington.

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[1] Fl. Foss. Helv., p. 78, Pl. XXX, Fig. 2.

[2] Paléont. Fr., Pl. Jurass., Pl. LXXIV, Figs. 1–3.

[3] Loc. cit., vol. 2, p. 337, etc.

Tribe CYCADEÆ.

CYCADITES PUNGENS, sp. nov.

Pl. II, Fig. 6.

Frond very rigid, with a broad rachis, convex or half-round on the lower side, leaves subopposite, oblique, narrow, linear-lanceolate, sharply acuminate, disconnected at base and joining the rachis by their whole base which is neither enlarged nor narrowed; median nerve broad, flat, as broad as the flat borders on both sides of it.

This fragment is related by the character of the leaves to *C. Lorteti* Sap.,[1] the first with broader, longer pinnules, the second with shorter and broader ones, enlarged and connate at base in both species and merely acute or obtuse.

By the mode of attachment of the pinnules, which are neither narrowed nor enlarged and disjointed at base, this fragment does not agree perfectly with the characters of the genus Cycadites which, in Saporta (loc. cit., p. 65), is established for plants with leaves abruptly enlarged at base and decurrent. But the broad simple median nerve and the oblique direction of the very rigid leaves are against the reference of this fragment to any other genus of the Cycadeæ. Moreover some of the fragments figured by Saporta (loc. cit., Pl. LXXXIII, Fig. 7, for example) are represented with leaflets squarely joined at base to the rachis, as in our Fig. 6, Pl. II.

Habitat: Kansas. Communicated by Mr. H. C. Towner.

CYCADEOSPERMUM LINEATUM, sp. nov.

Pl. I, Fig. 14.

Seed oblong-ovate, slightly falcate, rounded at the lower end, short-acuminate at the other; testa smooth, transversely lineate, the lines distant, parallel; carena clearly marked longitudinally on both sides, the inner concave, the outer rounded.

The seed, which is 1.5^{cm} long and 7^{mm} in diameter, is comparable to the fossil *C. hettangense* Sap.,[2] which has also the carena marked on both sides but is somewhat broader and not falcate; and to *C. impressum* Nath.,[3] of which the impression shows the same form but without trace of carena. It is also comparable to the seeds of the living *Zamia integrifolia*, especially by

[1] Paléont. Fr., Pl. Jurass., vol. 2, p. 75, Pl. LXXXII, Figs. 1-3, and *C. Delessei* Sap., Ibid., p. 73, Pl. LXXXIII, Figs. 5-7.

[2] Paléont. Fr., Pl. Jurass., vol. 2, p. 238, Pl. CXVI, Fig. 6.

[3] Fl. vid. Bjuf, pt. 2, Pl. XVIII, Fig. 11.

its size and shape. In the living species, however, the seed is regular, not inclined to one side, and marked by three or four very thin costæ.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4077 of the collection of Mr. R. D. Lacoe, of Pittston, Pennsylvania.

CYCADEOSPERMUM COLUMNARE, sp. nov.

Pl. XLIV, Figs. 7–8.

Seeds large, obovate, constricted below the middle; truncate at base, striate or costate lengthwise; striæ thin, $4–5^{mm}$ distant; intervals smooth; texture hard, woody.

There are two fragments which seem to belong to two different species, one (Pl. XLIV, Fig. 7) is 4^{cm} long, 2.5^{cm} broad at the middle, marked lengthwise by thin striæ passing from the apex to the base; the other, more fragmentary, appears bordered and also traversed lengthwise in the middle by thick costæ. In both specimens the surface is smooth between the striæ.

This organism apparently represents a kind of fruit referable to the Cycadeæ. As far as I know the only fossil fragment of marked affinity to this is that figured by Heer, Fl. Foss. Helv., Pl. LVI, Figs. 28, 29, which he there briefly describes in a note on p. 178, under the name of *Laffonia helvetica*, and which the author considers as an egg of a shark or ray found in Jurassic strata. The texture of the organism figured here is apparently woody; its size is less than that shown in Heer's figure, but is not larger than that of *Cycadeospermum Pomelii* Sap.,[1] though this last differs greatly by its exactly ovate shape and smooth and striate surface. Its reference to the genus Cycadeospermum Sap. (Cycadinocarpus Schimp.) is however not positively ascertained. In the description of this genus Saporta remarks that the fruits referable to it as fruits of Cycadeæ are either large or small; that they are externally angular, smooth or longitudinally striate or costate as in the fruit under consideration. In the Carboniferous a number of fruits as large as or even larger than that from Kansas, described and figured under the generic name of Cardiocarpus,[2] have such a degree of likeness to it that one can but consider it as a vegetable organism.

Habitat: Ellsworth County, Kansas. Nos. 830 and 831 of the Museum of the University of Kansas. Collected by E. P. West.

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[1] Paléont. Fr., Pl. Jurass., Pl. CXVII, Fig. 9.
[2] Coal Flora, Pl. CIX, Figs. 22–25.

Order CONIFERÆ.

Tribe ABIETINEÆ.

PINUS QUENSTEDTI Heer.

Kreidfl. v. Moletein, p. 13, Pl. II, Figs. 5-9; Lesquereux, Cret. and Tert. Fl., p. 33, Pl. I, Figs. 3, 4.

Tribe ARAUCARIEÆ.

ARAUCARIA SPATULATA Newb.

Notes on Ext. Fl., p. 10; Illust. Cret. and Tert. Pl., Pl. II, Figs. 5, 5a; Lesquereux, Cret. and Tert. Fl., p. 30.

This species is apparently identical with *Abietites curvifolius* Dunk., Pflanzen aus dem Quadersandstein von Blankenburg, Palaeontogr., vol. IV, p. 180, Pl. XXXIII, Fig. 1.

BRACHYPHYLLUM CRASSUM, sp. nov.
Pl. II, Fig. 5.

Thuites crassus Lesq., Cret. and Tert. Fl., p. 32.

Branches robust, irregularly pinnately ramose and ramulose; branchlets oblique, either parallel and of the same size or variable in form, length, and position; cylindrical, obtuse; leaves very close, imbricating, enlarged at base, rhomboidal, thick, coriaceous, inflated or glandulose at the apex.

The specimen represents an impression exactly copied, where the lower part of the imbricated leaves remain, of course covered and invisible. This species is comparable to *B. Moreauanum* Brongn., as represented in Saporta's Plantes Jurassiques,[1] differing essentially in the leaves being more equal and more distinctly rhomboidally inflated at the apex.

Habitat: Salina, Kansas. No. 345 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

DAMMARITES CAUDATUS Lesq.
Pl. I, Figs. 9, 10.

Podozamites caudatus Lesq. and *P. prælongus* Lesq., Cret. and Tert. Fl., p. 29.

Leaves thick, coriaceous, ovate-lanceolate, acuminate, rounded and gradually narrowed in passing downward to a short and narrow pedicel,

[1]Vol. 3, p. 341, Pl. CLXVI, Fig. 1.

inflated at the point of attachment, taper-pointed or long-acuminate; nerves parallel, thin, numerous, coming close together and dichotomous near the base.

Nothing similar to these leaves has been published in fossil plants, and indeed no living plants are comparable to them, except the large leaves of some species of Dammara; those, for example, of *D. robusta* Moore, from Australia, which are 14^{cm} long, $4–5^{cm}$ broad in the middle, and resemble in their form Fig. 10 of our plate. This leaf does not appear narrowed above into a long acumen like that of Fig. 9, which may represent a different species, as its base is not quite as narrow or visibly inflated.

The nervation of these fossil leaves is the same as that of *D. robusta*, and in Fig. 10 the leaves are narrowed in the same manner as in the living plant to a short petiole, which is a little enlarged at the inflated point of attachment. The nerves of *D. robusta* number 7–8 in 5^{mm} of diametral space, or a little more than 0.5^{mm} distant. In the fossil leaf they are $1–2^{mm}$ apart, rarely less.

In both fossil and living leaves the nervation is more or less effaced by compression of the thick coriaceous substance. The relation of these leaves to the genus Dammara is confirmed by the discovery of two species of fruits of this kind described by Heer from the Cretaceous of Greenland, *D. borealis* and *D. microlepis*.[1]

Habitat: Ellsworth County, Kansas. No. 1178 of the National Museum. Fig. 10 is No. 200 of the collection of the Museum of Comparative Zoology of Cambridge, Massachusetts.

DAMMARITES EMARGINATUS Lesq.

Pl. I, Fig. 11.

Podozamites emarginatus **Lesq., Cret. and Tert. Fl., p. 29.**

Leaves very thick, half tubulose or very concave on the lower side, entire on the border, linear-oblong, rounded and emarginate at the apex, narrowed from the middle downward to a flat, short, broad pedicel. Nerves parallel, close but distinct, 1^{mm} distant, converging near the upper border toward the apex of the leaf and at the base to the petiole, and there dichotomous.

No form has been found to which it is possible to refer this leaf, which is beautifully preserved and seems by its nervation and its short flat petiole to be referable to Dammara.

[1] Fl. Foss. Arct., vol. 6, 2 Abth., p. 54, Pl. XXXVII, Fig. 5; p. 55, Pl. XL, Fig. 5.

Habitat: Seven miles north of Glascoe, Kansas. No. 511 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

Tribe TAXEÆ.

PHYLLOCLADUS SUBINTEGRIFOLIUS Lesq.

Pl. II, Figs. 1, 2, 3.

Cret. Fl., p. 54, Pl. I, Fig. 12. *Thinnfeldia Lesquereuxiana* Heer, Fl. Foss. Arct., vol. 6, 2 Abth., p. 37, Pl. XLIV, Figs. 9, 10; Pl. XLVI, Figs. 1–12.

Leaves coriaceous, oblong, tapering downward to a short petiole, obtuse at apex, obtusely dentate above; midrib narrow, half round, slightly defined in the small leaves, distinct up to near the apex in the larger ones, and of the same thickness as the petiole; lateral nerves close, more distinct, of equal size and equidistant in the small leaves, irregular in size and distance in the larger, here and there inflated and more prominent; angle of divergence 20°.

The leaves, as far as I have seen them, vary from 3^{cm} to 12^{cm} in length, and from 1^{cm} to 3^{cm} in width in the middle or above, being there either undulate or obtusely dentate; the lateral nerves are obscurely defined, and are either simple or forking at a very acute angle of divergence, the divisions reaching the borders.

The genus Thinnfeldia Ett., to which Heer has referred leaves of apparently the same kind as the one described in Cret. Fl. (loc. cit.), is characterized by its author as follows: "Fronds pinnatifid; pinnæ or leaflets oblong, ovate-lanceolate, oblong-ovate, decurrent, confluent, coriaceous; primary nerves vanishing below the apex, divided into dichotomous nervilles, all the branches reaching the borders." Schimper remarks on the genus that the likeness of the fronds and leafy branches to those of the genus Phyllocladus has induced Ettingshausen to place these plants with the conifers. On the other hand Schenk considers them as Cycadeæ, while F. Braun has referred them to the ferns. This last opinion is admitted by Schimper, and judging from the species which I have been able to see figured (*Thinnfeldia rhomboidalis* Ett.,[1] *T. saligna* Schenk,[2] *T. rotundata* Nath.,[3] *T. Nordenskiöldi* Nath.[4]) this opinion is evidently authorized. For in all these species the leaflets are decurrent or confluent, the median nerve is either in distinct or not seen at all, the lateral ones diverging at a far more open angle of divergence, distinctly forking once or twice. Nothing like

[1] Schimper, Pal. Vég., Atlas, Pl. XLV, Fig. 1.
[2] Nathorst, Fl. vid. Bjuf., pt. 1, Pl. I, Figs. 5, 6.
[3] Loc. cit., Figs. 9–12.
[4] Pfl. Pålsjö, Pl. VI, Figs. 4, 5.

that is seen in the leaflets of the genus Phyllocladus, in which the leaves are directly attached by a short petiole to round branches and are all gradually attenuated or cuneiform at the base, not decurring, and of which the lateral nerves, at a more acute angle of divergence, are mostly equal, simple, or forking once, irregularly inflated, directly passing from the median nerve to the borders. Comparing the leaves figured on Pl. II with those of the living species of Phyllocladus, especially of *P. rhomboidalis* Rich., of Tasmania, the accordance of the characters is evident, the only difference between the fossil and the living leaves being in the crenate borders of those of the last species.

It may be that the leaves described and figured by Heer (loc. cit.) do not represent the same species as those of the Dakota Group. All those of Heer are entire; one deeply lobed or lacerate at apex; two of them lanceolate, acute or acuminate; all of smaller size and the median nerve scarcely marked, even toward the base, while the lateral ones are distinct, not inflated; characters at variance with those of the leaves figured as above. Part of a branch is represented by Heer,[1] which in the mode of attachment of the leaves has some likeness to *Thinnfeldia Nordenskiöldi*. But all the leaves are narrowed at base to a short petiole and not decurrent, similar in this last character to those of Phyllocladus, and differing by the same from the genus Thinnfeldia.

Habitat: Found in many specimens in red shale ten miles northeast of Delphos, Kansas. No. 4064 of the collection of R. D. Lacoe, of Pittston, Pennsylvania.

Tribe TAXODIEÆ.

SEQUOIA REICHENBACHI Gein.

Pl. II, Fig. 4.

Heer, Fl. Foss. Arct., vol. 1, p. 83, Pl. XLIII, Figs. 1d, 2b, 5a; vol. 3, pt. 2, p. 77, Pl. XII, Figs. 7c–d; Pl. XX, Figs. 1–8; p. 101, Pl. XXVIII, Fig. 2; Pl. XXXIV, Fig. 1; Lesquereux, Cret. Fl., p. 51, Pl. I, Figs. 10–10b, cone.

ARAUCARITES REICHENBACHI Gein.

Charakt. sächs.-böhm. Kreidegeb., p. 98, Pl. XXIV, Fig. 4.

Branches thick, covered entirely by the leaves; branchlets alternate, long; leaves decurrent, open, falcate-incurved, linear-subulate, acuminate at apex, simple-nerved, solid; strobiles narrowly oval, about 1 inch in diameter; scales peltate, rhomboidal.

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[1] Loc. cit., Pl. XLVI, Fig. 11.

In my Cret. Fl. (loc. cit.) I have described and figured as referable to this species an isolated cone with its scales and seeds. Prof. Heer has contradicted this reference, therefore the fragment of a branchlet figured here is the first evidence observed in the Dakota Group of a species which has been found widely represented in the Lower and Middle Cretaceous of Greenland and of Europe. The identity of this fragment is sufficiently shown by the character of the leaves and their scars upon the branches, especially resembling Figs. 8, 8a, Pl. xx, and Fig. 1a, Pl. xxxiv of Heer's Fl. Foss. Arct., loc. cit.

Habitat: Seven miles south of Fort Harker, Kansas. No. 690 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

SEQUOIA FASTIGIATA Heer.

Hayden's Ann. Rept., 1874, p. 335, Pl. III, Figs. 2, 8, 8a; Cret. and Tert. Fl., p. 31.

SEQUOIA CONDITA Lesq.

Hayden's Ann. Rept., 1874, p. 335, Pl. IV, Figs. 5–7; Cret. and Tert. Fl., p. 32, Pl. I, Figs. 5–7, 9.

GLYPTOSTROBUS GRACILLIMUS Lesq.

Hayden's Ann. Rept., 1874, p. 337; Cret. and Tert. Fl., p. 32, Pl. I, Figs. 6, 6b; Cret. Fl., p. 52, Pl. I, Figs. 8, 11.

Tribe CUPRESSINEÆ.

INOLEPIS SPECIES Lesq.

Hayden's Ann. Rept., 1874, p. 337, Pl. IV, Fig. 8; Cret. and Tert. Fl., p. 33, Pl. IV, Figs. 8, 8c.

CONIFERS OF UNCERTAIN AFFINITIES.

ABIETITES ERNESTINÆ Lesq.

Cret. Fl., p. 49, Pl. I, Fig. 7.

SEQUOIA FORMOSA Lesq.

Cret. Fl., p. 50, Pl. I, Figs. 9, 9b.

GEINITZIA Heer, sp.

Cret. Fl., p. 54.

PTENOSTROBUS-NEBRASCENSIS Lesq.

Cret. Fl., p. 114, Pl. XXIV, Fig. 1.

MONOCOTYLEDONES.

Order GRAMINEÆ.

Tribe FESTUCEÆ.

Subtribe ARUNDINEÆ.

PHRAGMITES CRETACEUS Lesq.
Pl. II, Fig. 8.

Equisetum nodosum Lesq., Cret. and Tert. Fl., p. 25.

Part of rhizoma; branch irregular in thickness, partly linear and nodose; articulate at unequal distances, articulations more or less inflated, marked by round small scars of radicles.

As this is merely a fragment of a rhizoma related to Phragmites by its unequally distant irregular articulations, marked on the upper and lower side by round scars of radicles, it is not possible to define its species. For the generic relation it is not only comparable but really very similar to *P. œningensis* Al. Br., as figured by Heer,[1] especially in the irregular length of the nodes, which are somewnat inflated below the line of articulation. In this branch the scars of rootlets are very irregular in position, some being above, some below the articulations, exactly as they are represented in size and position in Heer (loc. cit., Fig. 5a).

This fragment was at first considered as part of a rhizoma of Equisetum; but its analogy is more marked with Phragmites, a genus which is already represented in the Dakota Group by fragments of leaves and stems;[2] hence its reference to the same species, though hypothetical, seems to be authorized.

Habitat: Seven miles northeast of Glascoe, Kansas. No. 473 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

Order ALISMACEÆ.

Tribe ALISMEÆ.

ALISMACITES DAKOTENSIS, sp. nov.
Pl. II, Fig. 10.

Leaves subcoriaceous, entire, long-petioled, elliptical, acuminate; median nerve strong; secondaries, two pairs, inequidistant, curving up and tending to the apex at a very acute angle of divergence; simple.

[1] Fl. Tert. Helv., vol. 1, Pl. XXII, Figs. 5a, 5b.
[2] Cret. Fl., p. 55, Pl. I, Figs. 13, 14; Pl. XXIX, Fig. 7.

The substance of the leaf was apparently thick but soft, as the surface is covered by a granulose matter resulting from the decomposition of the epidermis and rendering the tertiary nervation totally obsolete. The petiole is nearly 5^{cm} long, the median nerve thick, and the secondaries, two pairs, simple, inequidistant, the lowest vein on the left side being basilar, thin, short, curving close to the borders, the upper emerging a little above the base and passing nearly straight up to the apex, while on the right side the lower secondary is supra basilar, nearly opposite to the upper one of the left side, curving in ascending, anastomosing in the upper part of the leaf with the upper secondary, which comes out from the midrib above the middle of the leaf and is acrodrome. The leaf is regularly elliptical, acuminate, and nearly 8^{cm} long and 3^{cm} broad at the middle, with its short acumen, which was originally constricted or pinched, split by compression.

As indicated by its form, the nervation and the long petiole, the leaf is evidently that of a monocotyledonous plant. But for the absence of the tertiaries at right angles to the midrib it would be referred to the genus Alisma. Saporta[1] has described without figures as *Alismacites lancifolius*, a leaf which seems to be closely related to this one. It is petioled, lanceolate, trinerved, the lateral nerves curved, tending toward the apex with secondaries or nervilles transversely ramose, scarcely visible. The author remarks that the leaf is of uncertain affinity, reproducing the type of many species of Alisma.

Habitat: Ellsworth County, Kansas. No. 758 of the collection of the museum of the University of Kansas. Collected by E. P. West.

Order ARACEÆ.

Tribe COLOCASIOIDEÆ.

Subtribe SPATHICARPEÆ.

ARISÆMA CRETACEA, sp. nov.
Pl. XLVI, Fig. 1.

Organism apparently cylindrical in its original state, enlarged upward, of membranous texture, striate lengthwise; striæ parallel, close, straight, rigid and distinct in the middle of the cylinder, diverging; curved outside and flexuous toward the borders.

[1] Études, vol. 1, p. 75.

The specimen represents a cylindrical ovate spathe of a monocotyledonous plant like an Arisæma. It may be compared by its form and size to *Ottelia parisiensis*, figured by Saporta in his Monde des Plantes, p. 227. The borders of the specimen seem to have been compressed and the nervation deformed. It is rather a spike, however, than a pericarp.

Habitat: Near Fort Harker, Kansas. No. 2710 of the U. S. National Museum Catalogue.

Order PALMÆ.

FLABELLARIA? MINIMA Lesq.

Cret. and Tert. Fl., p. 34; Cret. Fl., p. 56, Pl. xxx, Fig. 12.

Order LILIACEÆ.

Tribe SMILACEÆ.

SMILAX UNDULATA, sp. nov.

Pl. XLVI, Fig. 2.

Leaf membranous, thin but hard, ovate, acuminate, rounded at base in narrowing to the midrib, which it joins in decurring to it, entire, three-nerved, midrib narrow, straight; lateral nerves emerging from the base, ascending midway between the borders and the midrib, undulate, acrodrome.

The tertiary nerves, or nervilles, are very distinct and strong, passing obliquely upward from the midrib to the lateral nerves, then in the same direction from the lateral nerves to near the borders where they curve in oblong areoles, traversed by branches at right angles or in an oblique direction, forming an elongated, very loose areolation, most like that of some water plants (the Alismaceæ, for example), or like that of some fossil leaves referred to Smilax, such as *S. Haidingeri* Ung. (Sylloge, pt. 1, p. 7, Pl. I, Fig. 11); *S. Tarigonii* Gaudin (Contrib. Fl. Foss. Ital., 2d Memoir, p. 59, Pl. x, Fig. 5).

The leaf is about 7^{cm} long, 5^{cm} broad at the middle. Except that it is not cordate, it much resembles, especially by its nervation, *S. subhispida* Muhl.

Habitat: Near Fort Harker, Kansas. No. 2730 of the U. S. National Museum Catalogue.

SMILAX GRANDIFOLIA-CRETACEA, sp. nov.
Pl. XLVI, Fig. 3.

Leaf large, coriaceous, entire, hastate-cordate or subauriculate at base, acuminate, five-nerved from the base, the two external nerves short, arcuate, the inner much longer, subacrodrome, vanishing below the apex, branching outside, the branches arched, of varying length, simple or forking; secondaries few, at right angles to the midrib; areolation obsolete.

The leaf is partly destroyed on one side, yet has its essential character clearly preserved. Its length is 9^{cm}, its width 8^{cm} in the lower part, where apparently it had its widest diameter; the border, gradually rounding, descends a little lower than the base of the midrib, and then tending upward from a broad sinus or short broad auricles.

The leaf is related to *Smilacites grandifolia* Ung.,[1] a leaf deeply sagitate-cordate at base, eleven-nerved. Still more intimately related to the same species is *Smilax grandifolia* Heer, as figured by Ettingshausen,[2] two leaves still larger than that from Kansas, five-nerved, the lateral nerves disposed and branching as seen in our figure, the base of the leaves broadly rounded and forming as in our species, a broad narrow sinus between the basilar borders.

Though the upper part of the leaf figured in the Flora v. Bilin is destroyed, the fragment indicates for the whole a form similar to that of our plate. The leaves of the species illustrated in Heer's Fl. Tert. Helv. (vol. 1, Pl. xxx, Fig. 8), are much smaller, and the borders are less prolonged downward, so that the base of the leaf is rounded truncate. Considering the remarkable likeness of the leaf of *S. grandifolia* to those described in the Bilin Flora, and the great variety of characters as represented in the figures by various authors, it would seem reasonable to admit the leaf of the Dakota group as representing the same species as that of the Miocene of Europe.

It is to be remarked that the four leaves of *Smilax grandifolia* figured in Unger's Sylloge (pt. 1, Pl. II, Figs. 5–8), are seven-nerved; one (Fig. 7) is five-nerved. Hence, the difference in the form of the leaves and the number of nerves is of no importance, or at least is not specific. Heer[3] represents the species by a fine, entire, smaller leaf with five nerves, the lowest short, ascending to the middle; the median long, acrodrome; the other characters are also the same as in the leaf from Kansas.

Habitat: Kansas.

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[1] Chlor. Protog., p. 129, Pl. XL, Fig. 3.
[2] Flora von Bilin, p. 104, Pl. VI, Figs. 15, 16.
[3] Fl. Foss. Arct., vol. 2, pt. 4, Pl. XLV, Fig. 7.

Order DIOSCOREACEÆ.

DIOSCOREA? CRETACEA Lesq.

Cret. Fl., p. 56, Pl. XXVIII, Fig. 10; Cret. and Tert. Fl., p. 34.

Order BROMELIACEÆ.

Tribe BROMELIEÆ.

BROMELIA? TENUIFOLIA, sp. nov.

Pl. I, Fig. 13.

Leaves apparently long, linear, very gradually narrowed upward, distantly spinous, short-dentate; nerves parallel, thin, close, equal and equidistant.

The generic reference of such a small fragment of leaf as that figured is of course uncertain. Some palms of the genera Acrocomia Mart., Astrocaryum Meyer, etc., have their fronds covered with spines and the leaves also sometimes bordered with spinous teeth; but these are longer, more numerous, and irregularly placed. The leaves also of some species of Pandanus (*P. ornatus*, for example) are spinous on the borders, but they all have a distinct midrib, and thus it seems that the fragment from Kansas is referable to the Bromeliaceæ, having a degree of likeness to the leaves of Bonapartea, cultivated in the gardens, and also in the fossil species *Bromelia Gaudini*, Heer,[1] which may serve as a point of comparison, although the leaves are comparatively narrower, the nervation obsolete, and the spines of the borders much longer and generally at right angles.

The fragment is 6.5^{cm} long, 2.5^{cm} broad, marked by 40 parallel nerves, 15 or 16 in a diameter of 1^{cm}, all equal in size and distance. As in the leaf of Encephalartos the nerves nearest to the borders enter them and pass out, forming short acute teeth or spines turned upward.

Habitat: Ellsworth County, Kansas. No. 46 of the museum of the University of Kansas. Collected by A. Wellington.

[1] Fl. Tert. Helv., vol. 1, p. 107, Pl. XLIX and L.

DICOTYLEDONES.

Order SALICINEÆ.

POPULUS BERGGRENI Heer.

Pl. VIII, Figs. 2–4.

Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 106, Pl. XXIX, Figs. 1–5; vol. 6, 2 Abth., p. 63, Pl. XVII, Fig. 8a; Pl. XVIII, Figs. 1–4a,b, 9a, 10a; Pl. XIX, Fig. 1a; Pl. XL, Fig. 7a; Pl. XLI, Fig. 1; Pl. XLV, Fig. 12.

Leaves subcoriaceous, oval, equally narrowed upward to a blunt apex, and downward to a long petiole, entire; median nerve strong; secondaries thin; slightly curved in passing toward the borders, camptodrome.

The species, which is common in the Cretaceous of Greenland, has been recently found in a few specimens in the Dakota Group. The leaves vary much in size. We have seen them from 5^{cm} to 8^{cm} long and 2^{cm} to 4^{cm} broad. The secondaries, traversing the blade at an angle of 35°–50°, are distant and parallel, those of lowest pair opposite, supra-basilar, having generally a thin marginal nerve underneath. The petiole, preserved entire in Fig. 2, is 2.5^{cm} long, somewhat thicker at the base.

The three leaves figured here correspond in their characters to those represented by Heer, our Fig. 2 being essentially similar to that in Heer;[1] Fig. 3 allied in the same degree to that of Fig. 2a of the same plate, and Fig. 4 to that of his Fig. 5. The form of the leaves is as variable as the size.

Habitat: The two leaves, Figs. 2 and 3, have been found in Ellsworth County, Kansas. No. 62 of the museum of the University of Kansas; A. Wellington, collector. Fig. 4 is from a specimen sent from Minnesota by Prof. N. H. Winchell.

POPULUS KANSASEANA, sp. nov.

Pl. XVII, Figs. 1–7.

Leaves small, with a slender petiole, elliptical-ovate, lanceolate acuminate or pointed, narrowing or rounding to the petiole but not decurring to it, entire; primary nerve thin; secondaries numerous, 6–8 pairs, the lower opposite, supra-basilar, with a thin, basilar nerville underneath, curved in the upper part, camptodrome, anastomosing along the borders in a single series of areoles.

[1] Loc. cit., vol. 3, Pl. XXIX, Fig. 4.

These leaves are generally small, being 2.5^{cm} to 6^{cm} long, 1.5^{cm} to 3^{cm} broad at the middle, with a slender, long petiole which is generally broken. The secondaries, at an angle of divergence of 45° variable in distance, more or less ramose, are often separated by thinner, shorter, parallel tertiaries and crossed by nervilles at right angles forming large meshes.

By their form and size they are closely similar to the small leaves of *P. mutabilis* Heer, a common and very variable species of the European Miocene; they are, however, generally narrower, longer acuminate and always quite entire. They have been abundantly found mixed with those of *Diospyros rotundifolia* (Figs. 8–11 of the same plate) with which they have a degree of resemblance, differing, however, always by the thinner texture and the pointed or acuminate apex.

Habitat: Ellsworth County, Kansas, in nodules. Nos. 411, 416, 471, 473, 480, 481, of the museum of the University of Kansas. Collected by E. P. West.

POPULUS HYPERBOREA Heer.

Pl. III, Figs. 9–11; Pl. VIII, Fig. 1; Pl. XLVII, Fig. 5.

Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 106, Pl. XXIX, Figs. 6–9; Pl. XXVII, Fig. 8d; Pl. XXX, Fig. 2b; vol. 6, Abth. 2, p. 64, Pl. XVII, Figs. 6, 7; Pl. XXI, Fig. 1a.

Leaves coriaceous, ovate or broadly oval, entire, obtuse, rounded at base to a long petiole or slightly curved downward in reaching it; median nerve strong; secondaries distant and ramose, camptodrome.

All the leaves seen from this species from the Dakota Group are about of the same size, that is 4^{cm} to 7^{cm} long, 5^{cm} to 6^{cm} broad at the middle, with a strong petiole 6^{cm} long. It is the same with the leaves figured by Heer, except one,[1] which does not seem to be referable to the species. They are also identical in the other characters except that the leaves from Greenland have the basilar border rounded to the petiole, as in Pl. III, Fig. 11, and Pl. VIII, Fig. 1, not at all narrowing at base, as in Figs. 9 and 10 of Pl. III. The difference is, however, of no specific value. The nervation is more distinctly marked in the leaves from Kansas, which are also better preserved.

The lower secondaries are supra–basilar, but have generally under them quite near the base a thin pair of nervilles which follow close to the borders, anastomosing with them; the upper ones are variable in distance, diverging 30°–40° from the midrib, little curved in traversing the blade, arched along the borders which they follow, anastomosing in simple, large areoles. The

[1] Loc. cit., Pl. XXIX, Fig. 7.

areas are traversed by very thin nervilles, which are oblique or at right angles to the secondaries.

Habitat: Ellsworth County, Kansas. Nos. 604, 754, 860 of the collection of the museum of the University of Kansas. Collected by E. P. West. Fig. 1, Pl. IX, from ten miles northeast of Delphos, Kansas, is No. 59 of Mr. R. D. Lacoe's collection.

POPULUS HARKERIANA, sp. nov.

Pl. XLVI, Fig. 4.

Leaf coriaceous, large, cordiform, obtusely short-acuminate, rounded at base to the petiole, entire; nervation palmately ternate from the base of the leaf; midrib stout, enlarged gradually from the middle to the base; lateral primaries curving inward in ascending to above the middle, where they unite with the lowest secondaries, which are far distant above.

This fine leaf is 9.5^{cm} long, 9^{cm} broad at the middle, the more enlarged part, and has a long, thick petiole, a part of which, 3^{cm} long, is preserved. Its form is comparable to that of *P. Gaudini* Fischer-Ooster, as figured by Heer,[1] but the nervation is of a different type, evidently of that of *P. arctica*, as will be seen in comparing some of the figures of this last species in Heer, Fl. Foss. Arct., vol. 1, Pl. IV.

Habitat: Near Fort Harker, Kansas. No. 2723 of the U. S. National Museum.

POPULUS STYGIA Heer.

Pl. III, Fig. 12.

Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 107, Pl. XXIX, Fig. 10; vol. 6, abth. 2, p. 64, Pl. XVII, Fig. 5; Pl. XVIII, Figs. 5–8; Pl. XXXIX, Fig. 5.

Leaves subcoriaceous, entire, distinctly cordate, obtuse at apex; primary nerves strong; secondaries ramose, the two or three lowest pairs generally nearer to each other, camptodrome, following the borders in areoles.

As seen from the specimens figured by Heer, the leaves are greatly variable in size, ranging from 3^{cm} to 7^{cm} in length, generally as broad as long. As yet we have from the Dakota Group only a fragmentary leaf of this species, which is about 4.5^{cm} in length and width. It has, however, the characters indicated by Heer clearly marked, viz, its cordate base, obtuse apex, and camptodrome nervation. Heer compares his species to *Populites lancastriensis* Lesq.,[2] remarking that the basal border of the leaf is not turned

[1] Fl. Tert. Helv., vol. 2, Pl. LXIV.

[2] Cret. Fl., p. 58, Pl. III, Fig. 1.

down to the petiole as in the leaf from Kansas, an error rectified by the specimens of Fl. Foss. Arct., vol. 6, where especially Figs. 7 and 8 of Pl. XVIII have that basilar curve well defined. The real difference between the two species is in the small size and obtuse apex of the leaves of *P. stygia*, while those of *Populites lancastriensis* are apparently lanceolate, pointed (the upper part is destroyed), and especially in the real camptodrome nervation, the secondaries forming a series of areoles in following the borders in *P. stygia*, while in *Populites lancastriensis* the secondaries either reach the borders by their extremities or are effaced toward the borders and not curved in areoles.

Habitat: Ellsworth County, Kansas. No. 567 of the museum of the University of Kansas; E. P. West, collector.

POPULUS ELLIPTICA Newb.

Later Ext. Fl., p. 16; Illustr. Cret. and Tert. Pl., Pl. III, Figs. 1 and 2.

POPULUS MICROPHYLLA Newb.

Later Ext. Fl., p. 17; Illustr. Cret. and Tert. Pl., Pl. III, Fig. 5.

POPULUS ? CORDIFOLIA, Newb.

Later Ext. Fl., p. 18; Illustr. Cert. and Tert. Pl., Pl. III, Fig. 7.

POPULITES STERNBERGII, sp. nov.

Pl. VII, Figs. 8, 9.

Leaf subcoriaceous, broadly ovate, pointed, much enlarged above the base, rounded to the petiole, entire or slightly undulate; primary nerve thick and straight to the apex; secondaries distant, parallel, forking near the border, curved upward in passing to the borders, subcamptodrome; nervilles simple, distant, at right angles to the secondaries, percurrent.

These two leaves are apparently referable to the same species, although differing in some parts. In Fig. 8 the secondaries and their branches are more distinctly craspedodrome, and their disposition less regular. The thick median nerve is also in this leaf disproportionate to the very thin, sharply marked secondaries, which are alternate or parallel, inequidistant, at an angle of divergence of 60°, all arched upward in traversing the lamina, simply forking near the borders, the lower of the secondaries on one side being arched downward, contrary to the upward curves of the others. In Fig. 9 the median nerve is not as thick; the secondaries are equidistant, stronger, and evidently camptodrome, curving quite near the borders, the lowest pair being very thin and marginal.

In the numerous specimens of the leaves of Populites of the Dakota Group, some of which may be referable to other generic divisions, there is a more or less marked difference in the secondary nervation, which sometimes appears camptodrome by the thinning of the nerves quite near the borders, and sometimes is distinctly craspedodrome, the borders being entire, undulate or denticulate by the outside projection of the nerves. These form a peculiar group, comprising *Populites cyclophyllus* Heer, *P. litigiosus* Heer Lesq., *P. elegans* Lesq., *P. lancastriensis* Lesq., *Populus ? cordifolia* Newb., and the *Populites Sternbergii*, now described.

The leaves of this group, like those of some others of the Cretaceous, seem to represent by gradual modifications intermediate forms, whose specific reference remains uncertain or difficult to fix.

Habitat: Two and one-half miles south of Glascoe, Kansas. Nos. 422 and 426 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

POPULITES LITIGIOSUS (Heer) Lesq.

Pl. VII, Fig. 7; Pl. VIII, Fig. 5; Pl. XLVI, Fig. 6; Pl. XLVII, Fig. 1.

Populus litigiosa Heer, Phyll. Crét. du Nébr., p. 13, Pl. I, Fig. 2; Newberry, Illustr. Cret. and Tert. Pl., Pl. III, Fig. 6; Pl. II, Fig. 1; Schimper, Pal. Vég., vol. 2, p. 691.

Leaves rounded, entire at the truncate or broadly cuneate base; lateral nerves in four pairs, the basilar opposite, the upper alternate distant; nervilles curved, continuous or divided.

The species is really little known, though often quoted. The above description is that of Heer, made from a mere fragment of a single leaf, of which the base and the median part only are preserved, the borders all around and the upper part being destroyed. Fig. 5 of our Pl. VIII agrees with what is seen of the leaf represented by Heer, and with his description, except that the number of the lateral nerves is greater, being six instead of four, with still one pair of basilar veinlets following close to the borders, and an intermediate nerve on one side included in the space between the base of the lowest lateral nerves and that of the leaf. But this leaf is much larger than that figured by Heer. The lateral nerves are all parallel, distant, straight, thinning toward the borders, ramose and craspedodrome, as well as their divisions, the borders being either entire or somewhat undulate. In Fig. 7, Pl. VII, the lower lateral nerves are not opposite, and the space between their point of attachment and the base of the leaf is much narrower. With the smaller size of the leaf it is the only point of difference between this and

Fig. 5, and as the basilar pair of nerves close to the borders is present, the identity of these leaves may be admitted.

There is the same degree of difference between the two leaves referred to this species here and in the illustrations of Dr. Newberry. One (Pl. III, Fig. 6) is larger; the lower pair of secondaries is at a distance from the base of the leaves; the lower secondaries are opposite, and there is still on one side a short thinner basilar nerve, while in the leaf of Pl. II, Fig. 1, which is smaller, the lowest lateral nerves join the midrib quite near the basal border of the leaf, and there is no basilar nerve underneath. In this leaf, moreover, the borders are entire and the nerves camptodrome, while in the other the upper border of the leaf appears crenulate, and the nerves reach the borders as craspedodrome. From this it appears that, with a slight modification, Heer's description of the species is exact, the difference being merely the result of varieties in the different leaves. Schimper says, however, in his description of these leaves, that they are coarsely dentate above (superne grosse dentatis), which is apparently a mistake. I have seen, however, more recently, a number of leaves with dentate borders (not coarsely dentate) having the same kind of nervation as the leaves figured in our Pls. VII and VIII, and also the same size and form.

They appear to constitute a variety of the species, as *Populus litigiosa* var. *denticulata*. But this does not prove that the leaf described by Heer as *P. litigiosa* nor those referred to it by Dr. Newberry and by myself pertain really to Populus, the nervation being generally craspedodrome and pinnatifid.

Habitat: Commonly found in the Dakota Group of Kansas and Nebraska. No. 4050, from Pipe Creek, Cloud County, Kansas, and No. 4138, from ten miles northeast of Delphos, Kansas, of Mr. R. D. Lacoe's collection. Fig. 1, Pl. LIX, from Fort Harker, Kansas, is No. 2770 of the U. S. National Museum.

POPULITES ELEGANS Lesq.

Pl. XLVI, Fig. 5; Pl. XLVII, Figs. 2, 3.

Cret. Fl., p. 59, Pl. III, Fig. 3.

The description of the species as it has been established in Cret. Fl. should be completed by the addition of the word dentate to the character of the borders, which indeed are as often dentate or undulate as entire. I have also to remark that the areolation of the leaves referable to this species appears more distinctly marked and that the leaves of *Populus litigiosa* Heer are as often dentate or undulate as those of *P. elegans.* It seems, therefore, that the more distinct areolation is the essential character that we have to separate these species by. But it might be supposed that the difference is due only to the preserved face of the specimen; the areolation being generally more distinct upon the lower surface of the leaves of Populus. In this case I have considered as an important character the position of the lower secondaries, which in the leaves of *P. elegans* are basilar or nearly so, and more irregularly disposed, while as seen in Fig. 3 of the species they are suprabasilar borders of the leaf. This character may not be persistent or specific and the variety in the nervation of these leaves, which have now been studied in great numbers, is so great that this separation can not be admitted without doubt. We have, however, not sufficient authority of the real character of *P. litigiosa* in the description and figure of Heer (Phyll. Crét. du Nébraska, Pl. I, Fig. 2), the only specimen seen by the author being a fragment of a leaf with the lower pair of secondaries suprabasilar, and a marginal pair of veinlets underneath just as seen in our Fig. 2, the borders of the leaf being destroyed above the base.

Habitat: Near Fort Harker, Kansas. No. 2760 of the U. S. National Museum.

POPULITES LANCASTRIENSIS Lesq.

Cret. Fl., p. 58, Pl. III, Fig. 1.

POPULITES CYCLOPHYLLUS (Heer) Lesq.

Cret. Fl., p. 59, Pl. IV, Fig. 5.

Populus cyclophylla **Heer, Proc. Acad. Nat. Sci., Philadelphia, Vol. 10, 1858, p. 266.**

SALIX HAYEI, sp. nov.

Pl. III, Fig. 7.

Leaves coriaceous, small, entire, oblong, blunt-pointed, cuneate in narrowing at base to a short petiole; primary nerve thick, secondaries at an open angle of divergence, close, numerous, anastomosing along the borders in festoons.

A small leaf, remarkable by its coriaceous texture, the close, parallel secondaries deeply marked, 10–11 pairs on a leaf, 4.5^{cm} long, $2\text{-}5^{cm}$ broad, at an angle of divergence of $50°$; petiole short, 6^{mm} long; nervilles distinct, at right angles to the secondaries, forming by subdivisions an irregular polygonal reticulation.

The nearest relative I know to this fine leaf is *Salix abbreviata* Göpp.[1]

[1] Tert. Fl. von Schossnitz, p. 24, Pl. XVII, Fig. 7.

It has also a degree of affinity to *S. Ræana* Heer,[1] differing by the more coriaceous texture, the secondaries at a more open angle of divergence, the areolation irregularly polygonal, etc.

Habitat: Ellsworth County, Kansas. No. 788 of the collection of the museum of the University of Kansas. Collected by E. P. West.

SALIX DELETA, sp. nov.
Pl. III, Fig. 8.

Leaves subcoriaceous, subfalcate, ovate-lanceolate, tapering to a blunt apex, rapidly narrowed and cuneiform to the slightly inequilateral base, entire, penninerved; median nerve percurrent, deeply marked but comparatively narrow; secondaries numerous, subopposite, parallel, distinctly camptodrome, curving in bows along the borders, separated by thinner tertiaries.

The lateral nerves, which are all at the same angle of divergence of 50°, are not more than 5^{mm} distant at the base, most of them separated by an intermediate tertiary nerve vanishing above the middle in anastomosing with the secondaries, or traversed at right angles by nervilles forming a large quadrangular areolation.

The appearance of the leaf is rather like that of a Ficus. The nervation, however, refers it to Salix, it being a peculiar species to which none of the willow leaves of more recent formations have any recognized affinity.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4096 of Mr. R. D. Lacoe's collection.

SALIX NERVILLOSA Heer.

Phyll. Crét. du Nébraska, p. 15, Pl. I, Fig. 3.

SALIX PROTEÆFOLIA Lesq.

Cret. and Tert. Fl., p. 42, Pl. I, Figs. 14–16; Pl. XVI, Fig. 3; Cret. Fl., p. 60, Pl. V, Figs. 1–4.

There are so many of these leaves, and they show, taken altogether, differences which, although too feeble to be considered as specific, may be placed under the following varieties:

SALIX PROTEÆFOLIA var. LINEARIFOLIA Lesq.
Pl. LXIV, Figs. 1–3.

Leaves long, narrow, linear, surface smooth; texture somewhat thick; secondaries not visible; midrib narrow. There are ten specimens from Ellsworth County, Kansas, in Mr. R. D. Lacoe's cabinet (Nos. 436–445).

[1] Fl. Foss. Arct., vol. I, p. 102, Pl XXI, Fig. 13.

SALIX PROTEÆFOLIA var. FLEXUOSA Lesq.
Pl. LXIV, Figs. 4, 5.

Leaves narrow and linear, flexuous or curved-falcate to one side; midrib slightly stronger than in the preceding variety, texture and size about the same. These leaves are similar to the two figured on Pl. III, Figs. 3 and 4, which I have described as a variety of *Myrica longa.*

The figure of *Salix flexuosa* Newberry, in Illustr. Cret. and Tert. Pl., Pl. I, Fig. 4, represents this form. There are seven specimens (Nos. 446-452) from Ellsworth County, Kansas, in Mr. R. D. Lacoe's cabinet.

SALIX PROTEÆFOLIA var. LANCEOLATA Lesq.
Pl. LXIV, Figs. 6–8.

Leaves shorter and somewhat broader, gradually narrowed to the apex, and more rapidly to the base, where they join a broad, short petiole; median nerve as in the preceding variety; secondaries obsolete, texture of the leaf the same. This form answers to the two leaves of *Salix cuneata* figured by Newberry.[1] There are twenty-two specimens (Nos. 453–474) all from Ellsworth County, Kansas, in Mr. R. D. Lacoe's cabinet. One specimen has the secondaries distinct, like that of *Salix proteæfolia* Lesq.;[2] but this leaf is short, linear-lanceolate, agreeing in form with the var. *flexuosa.* It is specimen No. 446 (our Fig. 4) of Mr. R. D. Lacoe's collection.

SALIX PROTEÆFOLIA var. LONGIFOLIA Lesq.
Pl. LXIV, Fig. 9.

A large, long leaf with cuneate base narrowed to a long acute tip (broken); midrib thick; secondaries prominent, subopposite; texture as in the other forms. One specimen from Ellsworth County, Kansas, (No. 475) in Mr. R. D. Lacoe's cabinet.

SALIX MEEKII Newb.

Later Ext. Fl., p. 19; Illustr. Cret. and Tert. Pl., Pl. I, Fig. 1.

SALIX CUNEATA Newb.

Later Ext. Fl., p. 21; Illustr. Cret. and Tert. Pl., Pl. I, Figs. 2, 3.

SALIX FLEXUOSA Newb.

Later Ext. Fl., p. 21; Illustr. Cret. and Tert. Pl., Pl. I, Fig. 4.

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[1] Loc. cit., Pl. I, Figs. 2 and 3a.
[2] Cret. and Tert. Fl., Pl. I, Fig. 15.

FRUITING CATKIN OF SALIX.

Pl. VIII, Fig. 6.

Salix species, a fruiting catkin, with small, somewhat distant pedicellate, cylindrical-ovate, pointed ovaries. This catkin is very similar to those of a number of living species of willows, especially to those of *S. fragilis* L. Among fossil organs of this kind it is comparable to Salix volkana Ludw.[1] It may be referable to *S. proteæfolia* Lesq., the only species abundantly distributed in the Dakota Group.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4062 of Mr. R. D. Lacoe's collection.

Order CUPULIFERÆ.

Tribe QUERCINEÆ.

FAGUS POLYCLADA Lesq.

Cret. Fl., p. 67, Pl. v, Fig. 6; Am. Jour. Sci. and Arts, vol. 46, 1868, p. 95.

FAGUS CRETACEA Newb.

Later Ext. Fl., p. 23; Illustr. Cret. and Tert. Pl., Pl. II, Fig. 3.

FAGUS ORBICULATUM, sp. nov.

Pl. XLVII, Fig. 6.

Leaves small, rounded in the upper part, broadly cuneate to the base, entire; midrib strong and straight, percurrent; secondaries simple, equidistant, straight, craspedodrome; nervilles thin, simple, distant, at right angles to the secondaries.

The leaf is remarkable by its simplicity and the regular disposition of all its parts. It measures vertically 4.5^{cm} and is of a nearly orbicular form, being only somewhat narrowed near the base. The secondaries (seven pairs), diverging from the midrib at an angle of 50°, pass straight up to the borders, being perfectly simple, parallel and craspedodrome; the tertiaries are also simple and very thin and are somewhat distant and at right angles to the secondaries, the areolation or their subdivisions being obsolete.

Except for the regular, nearly round form of this leaf, there is nothing in its appreciable character which indicates a deviation from the normal characters of the leaves of Fagus. The nervilles are somewhat more distant and the borders more perfectly entire than we see them in living species of

[1] Foss. Pfl. der Rhein.-Wett. Tert. Form., in Palaeontogr., vol. 8, 1859, p. 93, Pl. XXVII, Fig. 13, 13a, b, c.

the genus. But the same appearances are observable in the leaves of *Fagus deucalionis* Ung., the distance of the nervilles and size of the leaves being nearly the same as represented in Heer[1]; also in *F. Antipofii* Abich, the leaves of which are figured with the borders perfectly entire,[2] as well as in *F. cordifolia* Heer,[3] which was apparently originally subcoriaceous, seems to have been heavily compressed, and therefore looks thin, especially along the borders.

Habitat: Ellsworth County, Kansas. No. 224 of the collection of Mr. R. D. Lacoe, of Pittston, Pennsylvania.

QUERCUS SUSPECTA, sp. nov.
Pl. XLVII, Fig. 7; Pl. XLVIII, Figs. 1, 2.

Leaves large, coriaceous, broadly oval or nearly round, narrowed toward the base, undulate or obtusely dentate on the borders, obtuse or emarginate at apex; median nerve stout; secondaries strong, oblique, equidistant, simple or branching in the upper part, effaced before reaching the borders, craspedodrome.

The leaves are large, 7^{cm} to 13^{cm} in length, 6^{cm} to 9^{cm} in width, narrowing toward the petiole, with six to eight pairs of alternate secondaries, the lowest supra-basilar, all parallel, passing toward the borders at an angle of divergence of 40° to 50°, becoming thick from the middle downward, gradually thinning toward the borders, some of them branching.

The smaller one (Fig. 7, Pl. XLVII) is more distinctly, obtusely, and equally dentate; the secondaries, simple on one side, branch on the other, and are of the same character as those of Fig. 1, Pl. XLVIII, which is large, nearly entire or with undulate borders.

These leaves may be compared in size, form, and nervation to *Q. Wilmsii* and *Q. latissima* Hos.,[4] two species of doubtful relation, and also to *Q. Deloesi* Heer.[5] But the points of affinity do not sufficiently sustain the reference of these leaves to Quercus.

Habitat: Ellsworth County, Kansas. Nos. 217 and 226 of Mr. R. D. Lacoe's collection. Fig. 2 of Pl. LX, from near Fort Harker, Kansas, is No. 2757 of the U. S. National Museum catalogue.

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[1] Fl. Foss. Arct., vol. 4, pt. 1, p. 73, Pl. xv, Fig. 6.
[2] Fl. Foss. Arct. vol. 5, pt. 3, Pl. vi, Fig. 8; Pl. vii, Fig. 5.
[3] Loc. cit., vol. 7, Pl. xcii, Fig. 1.
[4] Dicotyl. der Westfäl. Kreideformation, p. 95, Pl. xii, Figs. 3–6, and p. 97, Pl. xiii, Fig. 11.
[5] Fl. Tert. Helv., vol. 2, p. 56, Pl. lxxviii, Fig. 7.

QUERCUS SPURIO-ILEX, sp. nov.[1]
Pl. XLVIII, Fig. 3.

Leaves small, coriaceous; oblong, ovate-lanceolate, abruptly pointed, truncate at base, dentate-spinose all around; midrib straight, rigid; secondaries open, more or less ramose or forking above, all the divisions entering the teeth, craspedodrome.

The leaf is similar in its form, the dentation of the borders, and the nervation to that of *Q. ilex* L., as represented by Schenk in Zittel's Handbuch der Paläontologie,[2] and it is also comparable to some of the forms of the leaves of *Q. chrysophylla* Kellogg and *Q. agrifolia* Née, both living species of California, and both species with leaves extremely variable in size and form like *Q. ilex*.

The leaf is about 3.5^{cm} long and 2^{cm} broad, and has seven pairs of secondaries at an open angle of divergence of from 50° to 60°; is dentate with unequal, sharply acuminate or acute, open teeth, which are nearly 3^{mm} long, separated by obtuse sinuses.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4032 of the collection of Mr. R. D. Lacoe.

QUERCUS WARDIANA, sp. nov.
Pl. VII, Fig. 1.

Leaf large, coriaceous, polished on the surface, entire or undulate, even obscurely distantly dentate, ovate-lanceolate, obtuse, gradually narrowed to the base; median nerve half round, comparatively narrow, of equal thickness in its whole length, rigid; lateral nerves alternate, close, nearly at right angles towards the base, gradually more distant upward and at a broad angle of divergence of 60°–70° above the middle, subcraspedodrome.

This fine leaf is about 17^{cm} long (the apex being broken), obtuse, 8.5^{cm} broad in the upper part, gradually narrowed from below the middle to the point of attachment, apparently a short petiole, which is broken. The upper secondaries are at an equal distance, parallel, strong, but the lower ones, six or seven pairs, are thinner, less distant, gradually shorter and more open, nearly at right angles.

[1] This species was named *Quercus pseudo-ilex*, sp. nov., by Prof. Lesquereux, but as this name is antedated by the *Quercus pseudo-ilex* of Kovats (Fossile Flora v. Erdobényе, 1856, p. 22, Pl. II, Fig. 6) it becomes necessary to change it. I have called it *Q. spurio-ilex* with a view to still preserving its implied relation to the living *Q. ilex*.—F. H. K.

[2] II Abth., 5 Lief., p. 436, Figs. 6–8.

Although strong, the upper secondaries curve before reaching the borders and enter them either by their ends or by subdivisions of their branches.

The species is distantly related to *Quercus* (*Dryophyllum*) *subcretaceum* (Sap.) Lesq.,[1] which has, however, the leaves narrow, dentate or crenate and the nervation camptodrome.

Habitat: Ellsworth County, Kansas. No. 4204 of the collection of Mr. R. D. Lacoe.

Quercus alnoides, sp. nov.
Pl. VII, Fig. 3.

Leaf coriaceous, obovate (broken at apex), entire or slightly flexuous along the borders, cuneate at base; secondaries inequidistant, more approximate towards the base, thick, mostly simple, camptodrome, the basilar pair marginal and very thin; nervilles distinct, at right angles to the secondaries, percurrent, simple or forking, and anastomosing in the middle.

Though the specimen represents only the lower part of a leaf, the characters noted above are clearly marked. The fragment indicates a leaf 6^{cm} to 7^{cm} long and 4.5^{cm} broad at or near the middle. The secondaries have an angle of divergence of about 50°, some of them close together, others 1^{cm} apart, separated by an intermediate tertiary, much thinner and shorter than the secondaries, and flexuous.

Species comparable to *Alnites pseudincana* Göpp.,[2] a leaf which, however, has the borders obscurely dentate. It is still more closely related to *Quercus Deloesi* Heer.[3] A point of comparison is found also in *Q. advena* Sap.,[4] a Tertiary species.

The reference of this leaf to Quercus has been questioned, but none other proposed. Considering the form of the leaf and its nervation the relation seems clearly marked with the living *Q. Championi* Benth., an example of which is figured by Schenk, Handbuch der Palæont., II Abth., 5 Lief., p. 436, Figs. 4, 5.

Habitat: Kansas. No. 429 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

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[1] Fl. Foss. Sézanne, Pl. V, Figs. 1–3.
[2] Tertiärfl. Schlesiens, Palaeontogr., vol. 2, 1852, p. 272, Pl. I, Figs. 5a, b.
[3] Fl. Tert. Helv., vol. 2, p. 56, Pl. LXXVIII, Figs. 6, 7, 14.
[4] Ann. Sci. Nat., Bot., 5^{me} sér., vol. 8, 1867, p. 67, Pl. V, Fig. 6.

QUERCUS GLASCOENA, sp. nov.
Pl. VI, Fig. 6.

Leaves subcoriaceous or membranous, with polished surface, ovate, obtuse, broadly cuneate to the petiole; borders entire, slightly undulate; median nerve thick; secondaries thin, few, five to six pairs, parallel, the lower ones opposite; nervilles oblique, thin, straight, simple, and percurrent.

The leaf is 6.5^{cm} long, broken or erased at the apex and thus apparently obtuse, nearly 5^{cm} broad below the middle; the secondaries thin, at an angle of 40° to 50°, are somewhat flexuous or slightly curved upward in traversing the lamina, mostly simple, craspedodrome, or the upper ones apparently camptodrome, the lowest pair suprabasilar; nervilles very thin, oblique to the nerves. The petiole is strong like the median nerve, broken 6^{mm} below the base of the leaf.

The leaf has, by its mixed nervation and undulate borders, the appearance of *Hamamelites fothergilloides* Sap.,[1] from which it differs by its form, its nearly entire borders and the wider divergence of the secondaries. It has a greater degree of affinity to *Quercus Larguensis* Sap.,[2] not only by its similar form but by the character of the nervation, the secondaries being equally distant, camptodrome or craspedodrome and the nervilles oblique to the secondaries.

Habitat: Seven miles northeast of Glascoe, Kansas. No. 482 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

QUERCUS ELLSWORTHIANA Lesq.

Cret. Fl., p. 65, Pl. VI, Fig. 7.

QUERCUS MORRISONIANA Lesq.

Cret. and Tert. Fl., p. 40, Pl. XVII, Figs. 1, 2.

QUERCUS SALICIFOLIA Newb.

Later Ext. Fl., p. 24, Illustr. Cret. and Tert. Pl., Pl. II, Fig. 1.

QUERCUS CUNEATA Newb.

Later Ext. Fl., p. 25.[3]

[1] Fl. Foss. Sézanne, p. 393, Pl. XI, Fig. 3.

[2] Études, vol. 3, p. 67, Pl. V, Fig. 1.

[3] *Quercus antiqua* and *Q. sinuata* Newb. (Later Ext. Fl., pp. 26, 27), from the lower Cretaceous sandstone, banks of Rio Dolores, southern Utah, are omitted here, as the geological stage of the formation is not identified with that of the Dakota group.

QUERCUS PORANOIDES Lesq.

Cret. Fl., p. 66, Pl. XXX, Fig. 9.

QUERCUS (DRYOPHYLLUM) PRIMORDIALIS Lesq.

Cret. Fl., p. 64, Pl. V, Fig. 7.

QUERCUS (DRYOPHYLLUM) DAKOTENSIS Lesq.
Pl. VII, Fig. 4.

Cret. and Tert. Fl., p. 39.

Leaves subcoriaceous, ovate-lanceolate, narrowed in an outside curve to the base, less abruptly attenuated to an acute or blunt apex (not distinct), entire toward the base, regularly dentate from the middle upward, short pedicellate; median nerve narrow, straight; secondaries thin, nearly straight, simple or divided into two or three branches, craspedodrome. It is closely allied to the preceding species.

Habitat: Kansas. No. 62 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

QUERCUS HEXAGONA Lesq.
Pl. VII, Fig. 5.

Cret. Fl., p. 64. Pl. V, Fig. 8.

Leaf rhomboidal-ovate, narrowed to a point from above the middle, tapering downward, cuneate at base, irregularly dentate above, nervation pinnate, simple, craspedodrome.

The leaf figured here is somewhat smaller than that described in the Cretaceous Flora. It has, however, the same characters. The basilar secondaries follow quite near the borders and parallel to them, entering into very short, slightly marked teeth, while the upper ones are alternate and pass to stronger acute teeth, that of the third pair being the largest of all in both specimens. To the first description of the species nothing has to be added but this, that the secondaries are not always simple, but sometimes once branching.

The relation of this species to *Q. Osbornii*, remarked in Cret. and Tert. Fl., p. 39, is not well defined. It is more distinctly marked with *Q. troglodites* Heer[1] of the Middle Cretaceous or Senonian of Atanekerdluk, a species which appears nearly identical, differing merely by shorter, more obtuse

[1] Fl. Foss. Arct., vol. 6, 2 Abth, Pl. XXIV, Fig. 14.

teeth and the absence of a basilar marginal veinlet, which is well marked in both specimens of the Dakota Group.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4017 of the collection of Mr. R. D. Lacoe.

QUERCUS (DRYOPHYLLUM) HOSIANA, sp. nov.

Pl. III, Fig. 14.

Leaf coriaceous, small, ovate or short ovate-lanceolate, pointed, rounded and narrowed at base, somewhat inequilateral, unequally dentate-repand on the borders, entire toward the base; primary nerve strong; secondaries, of which there are six pairs, at an angle of divergence of 50° to 60°, arched in passing toward the borders, subcraspedodrome or entering the teeth by short branches of the secondaries.

This leaf is like the upper part of some of the numerous leaves of *Q. westfalica*, figured in Hosius, Fl. Westfäl. Kreidef., p. 161, Pls. XXIX and XXX, the only difference being in the very reduced length of the leaf, which, with that exception, has all the characters described by the author. As seen in the figure, the secondaries pass under the teeth and are camptodrome, while their branches enter them. This character is essentially considered by Saporta as proper to the subdivision Dryophyllum of the genus Quercus.

Habitat: Probably ten miles northeast of Delphos, Kansas. No. 4152a of the collection of Mr. R. D. Lacoe.

QUERCUS (DRYOPHYLLUM) RHAMNOIDES, sp. nov.

Pl. XLVIII, Fig. 4.

Leaves subcoriaceous, oblong-lanceolate, rounded in narrowing to the base, blunt or obtuse at apex; borders entire or slightly undulate; midrib comparatively narrow, straight, half round; secondaries numerous, parallel and equidistant, a little curved in passing toward the borders, camptodrome, incumbent in festoons quite near the borders; tertiaries strong, at right angles or slightly oblique to the secondaries, numerous, rarely simple, mostly forking at the middle, composing by subdivisions an irregular, small, quadrate areolation.

The leaves representing the species are somewhat lacerated, the best preserved being 7^{cm} long, 4^{cm} broad at the middle, and has sixteen pairs of narrow, thin secondaries, deeply marked, mostly simple, diverging from the midrib at an angle of 40°, united by nervilles close and at right angles.

The species has a near affinity of character to *Dryophyllum Eodrys*, represented by Fig. 19, in Debey, Feuilles querciformes, from which it merely differs in its slightly greater breadth and less distant secondaries. It has also a marked degree of relation, especially in the form of the leaf and the nervation, to *Quercus nevadensis* Lesq.[1] or to *Dryophyllum aquamarum* Ward.[2]

Habitat: Ellsworth County, Kansas. No. 219 of the collection of Mr. R. D. Lacoe.

QUERCUS (DRYOPHYLLUM) HIERACIFOLIA (Deb.) Hos. & v. d. Marck.
Pl. III, Fig. 15.

Hos. & v. d. Marck, Fl. d. Westf. Cret. Form., p. 166, Pl. XXXI, Figs. 85–88; Heer Fl. Foss. Arct., vol. 6, 2 Abth., p. 68, Pl. XXV, Figs. 2b, c, 4.

Leaves coriaceous, lanceolate, narrowed to the rounded base, sparingly sinuate-dentate, primary nerve thick; secondaries at an acute angle of divergence.

This leaf, though fragmentary, well represents the species as figured by Heer (loc. cit.), being especially like his Fig. 2c. The teeth are shorter, more obtuse, and more oblique than in the figures given by Hosius, but the nervation is identical; the simple secondaries curve in traversing the blade at an angle of divergence of 45° to 50°, reaching the teeth by their extremities. The areolation is obsolete.

Habitat: Ellsworth County, Kansas. No. 726 of the museum of the University of Kansas. Collected by E. P. West.

QUERCUS (DRYOPHYLLUM) LATIFOLIA Lesq.

Cret. and Tert. Fl., p. 37, Pl. IV, Figs. 1, 2.

QUERCUS (DRYOPHYLLUM) HOLMESII Lesq.

Cret. and Tert. Fl., p. 38, Pl. IV, Fig. 8.

GALLA QUERCINA, sp. nov.
Pl. VII, Fig. 2.

Globular; surface smooth, polished; point of attachment transversely oval, small, wrinkled around, at right angles to the point.

These organisms appear to represent oak galls, being in their characters and appearance different from the round, ferruginous concretions found in some localities of the Dakota Group, which are always rough on the sur-

[1] Foss. Plants of the Auriferous Gravel, p. 5, Pl. II, Figs. 3 and 4.
[2] Types of the Laramie Flora, p. 26, Pl. X, Figs. 2 and 3.

face. These galls, of which there are four specimens, vary in size from that of a pea to that of a large walnut; they are all perfectly globular, very smooth, shining, of black color, easily detached from the coarse, red matter which contains them, and marked with a smooth cicatrice like the point of attachment and a few irregular, round perforations like those made upon oak galls by the egress of the insects.

Habitat: Found all together at the same locality, Ellsworth County, Kansas; A. Wellington, collector. No. 5 of the collection of the museum of the University of Kansas.

Tribe BETULEÆ.

ALNITES GRANDIFOLIUS Newb.

Later Ext. Fl., p. 9; Illust. Cret. and Tert. Pl., Pl. IV, Fig. 2.

BETULA BEATRICIANA Lesq.

Pl. III, Fig. 16.

Cret. Fl., p. 61, Pl. V, Fig. 5; Pl. XXX, Fig. 4.

A fragment, the upper part of a leaf, apparently referable to this species, which as yet is not sufficiently known.

Habitat: Ellsworth County, Kansas. No. 518 of the collection of the museum of the University of Kansas; E. P. West, collector.

BETULITES Heer.

This generic division has been already used by Heer for the description of two fragmentary leaves of the Dakota Group (*Betulites denticulatus* Heer, Phyll. Crét. du Nébr., p. 15, Pl. IV, Figs. 5, 6). I refer to it now a large number of leaves, remarkably well preserved in ferruginous concretions, mostly obtained by Judge West in the Dakota Group of Kansas. All these leaves show, far more distinctly than those described by Heer, a relation to Betula.

First. By the form and size of the leaves, which are ovate, blunt-pointed or oblong-obtuse, round, reniform, truncate, subcordate or broadly cuneate at the entire marginal base, which terminates in the lowest teeth of the borders; all forms identical with those of the leaves of the common *B. nigra* L.

Second. By the nervation, which is regularly pinnate, the median nerve straight and narrow, the secondaries oblique, equidistant and parallel, passing straight to the borders, craspedodrome, the lowest pairs generally supra-basilar and opposite, ramose on the lower side, with nervilles distinct and at right angles.

Third. By the denticulation of the borders, being much like that of the species of Betula or of Alnus, the teeth being more or less distinct, sometimes marked by mere points on the border at the extremities of the secondaries and of their divisions entering them.

Fourth. By the long, slender petiole of the leaves.

Of course there are some points of difference which may be remarked in examining separately some of the leaves; but none affecting them in their general, and therefore their generic, character.

There is even between these leaves such a degree of affinity that their separation into species is extremely difficult. They look as if they had been derived from a single tree or from a group of low bushes of the same species, of which, as is the case with plants of our time, some differences are remarked in leaves separately examined and compared. The petiole of these leaves bears at its base a small, bifid stipule, with lanceolate, pointed lobes. This organism, however, is rarely preserved.

The task of studying these leaves, represented by hundreds of specimens, has been hard, indeed, but at the same time pleasant and instructive. For it has been rarely possible as yet to obtain in a fossil state such a number of perfectly preserved fossil leaves, which, like these, may be studied as easily as those of plants in the herbarium or even as if they were still in process of growth, and thus afford clear evidence of the multiple modifications which, in geological times, may have affected the plants of the same species. It is admissible that if these leaves had been discovered separately at divers times and at divers localities they might have been referred by authors to a number of species. In the present case it is scarcely possible to doubt their relation to a single species. Nevertheless, in order to remark on some appreciable differences in their characters I have described them here under the name of *Betulites Westii* and subdivided the species into a number of varieties.

BETULITES WESTII, sp. nov.

Pl. IV, Figs. 1–22; Pl. V, Figs. 5–14.

Leaves of small size, long-petioled, subcoriaceous, ovate-oblong, obtuse or blunt at apex, truncate, subcordate or broadly wedge-form at the entire base; borders subentire or more or less distinctly denticulate; nervation pinnate, craspedodrome; primary nerves straight, narrow; secondaries 6–10 pairs, oblique, parallel, equidistant, the lower opposite and suprabasilar; nervilles distinct at right angles; petiole slender, 10–18^{mm} long, stipulate at base.

Habitat: Ellsworth County, Kansas. All the specimens numbered below belong to the museum of the University of Kansas. Collected by E. P. West.

1. Betulites Westii var. subintegrifolius.[1]

Pl. IV, Figs. 1–4.

Leaves broadly ovate or oval, obtuse; truncate or subcordate at base; borders nearly entire, minutely punctulate by the points of the extremities of the secondaries entering the borders; secondaries distant, six pairs at an open angle of divergence of 45° to 50°. Nos. 302, 313, 375, and 378 of the collection.

2. Betulites Westii var. obtusus.

Pl. IV, Figs. 5–8.

Leaves oblong-oval, rounded at apex, subtruncate at base; minutely denticulate; secondaries of the same character as in the preceding. Nos. 235, 241, 260, and 263 of the collection.

3. Betulites Westii var. latifolius.

Pl. IV, Figs. 9–11.

Leaves larger, 4–6^{cm} long, ovate, blunt-pointed, distinctly denticulate, subtruncate at base. Nos. 268, 269, and 276 of the collection.

4. Betulites Westii var. rotundatus.

Pl. IV, Figs. 12–16.

Leaves small, 1.5^{cm} to 3^{cm} in diameter both ways, or sometimes slightly broader than long, minutely denticulate. Nos. 246, 344, 351, 380, and 397 of the collection.

5. Betulites Westii var. oblongus.

Pl. IV, Figs. 17–19.

Leaves small, of same size as in the preceding variety, oblong-ovate, obtuse, subtruncate at base, denticulate. Nos. 281, 296, and 328 of the collection.

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[1] Prof. Lesquereux gave all the varieties of this species the feminine termination (subintegrifolia, etc.), as if treating of Betula. I have taken the liberty to change this to the masculine form to agree with Betulites.—F. H. K.

6. BETULITES WESTII var. INÆQUILATERALIS.
Pl. V, Figs. 10-13.

Leaves very small, more enlarged on one side, oblong, rounded at apex, distinctly denticulate. Nos. 355, 366, 391, and 403 of the collection.

7. BETULITES WESTII var. MULTINERVIS.
Pl. IV, Figs. 20-22.

Leaves ovate-lanceolate or deltoid, obtuse at apex; truncate or broadly cuneate at base; secondaries eight to ten pairs, borders distinctly denticulate. Nos. 273, 291, and 396 of the collection.

8. BETULITES WESTII var. CUNEATUS.
Pl. V, Fig. 8.

Leaves rounded above, cuneiform at the base; secondaries at a more acute angle of divergence (35°), borders denticulate. No. 318 of the collection.

9. BETULITES WESTII var. RENIFORMIS.
Pl. V, Fig. 5.

Leaves enlarged in the middle, round above, cordate at base, reniform; borders denticulate. No. 345 of the collection.

10. BETULITES WESTII var. RHOMBOIDALIS.
Pl. V, Figs. 6, 7.

Leaves large, rhomboidal in outline, blunt-pointed, broadly cuneate to the long petiole. Nos. 301 and 304 of the collection.

11. BETULITES WESTII var. QUADRATIFOLIUS.
Pl. V, Fig. 9.

Leaf 4^{cm} long, 4.5^{cm} broad, truncate at base and apex, lateral borders nearly parallel; secondaries, five pairs, subopposite, distant, teeth distant, more sharply marked.

The specimen bears near the base of the petiole a bunch of small pediceled seeds like those of a Carex. No. 246 of the collection.

12. BETULITES WESTII var. LANCEOLATUS.
Pl. V, Fig. 14.

Leaves lanceolate, pointed, rounded at base, denticulate: secondaries at an angle of divergence of 30° to 40°. The lower slightly curved back in traversing the blade; ramose.

The nervation of this leaf is of course modified according to its shape, but is not specifically distinct. No. 474 of the collection.

13. Betulites Westii var. crassus.
Pl. V, Figs. 15–17.

Leaves coriaceous, of various forms, round, obtuse or deltoid, acute, cuneate or truncate at base; nervation thick; secondaries simple or ramose; borders distinctly, even sharply, denticulate.

Although these leaves, which have been obtained from another locality, differ especially in form and could thus be referred to three different species, yet the analogy remarked between all those described as *B. Westii* shows that they have in their characters such differences only as can be considered varietal. The coriaceous substance of these three leaves and the thick nervation might, however, be regarded as constituting specific differences. Nos. N, K, B.

14. Betulites Westii var. populoides.

The form of the leaf is like that of a Populus, being truncate or subcordate at base, much enlarged in the lower part, where it becomes rounded and tapers rapidly to the apex. The nervation is that of *Betulites Westii* var. *subintegrifolius*, but the lowest pair of secondaries is basilar, the others parallel, all running straight to the borders, which they enter craspedodrome, being mostly simple, except the lowest pair. The leaf is an impression of the upper surface and is somewhat obscure.

15. Betulites Westii, var. grewiopsideus.
Pl. LXIV, Fig. 10.

A fine, small round leaf, with the nervation of *Grewiopsis orbiculata* Sap.[1] The teeth of the border are somewhat longer and more distinct than the leaf from Kansas. As the same character of nervation is observable upon some of the leaves which I have referred to Betulites, and as the petiole, which is rigid, 1.5^{cm} long, bears at its base a short-pointed stipule like that described in leaves of Betulites, the reference to this genus is authorized.

Habitat: Ellsworth County, Kansas. No. 1205 of the collection of Mr. R. D. Lacoe.

[1] Fl. Foss. Sézanne, p. 411, Pl. xi, Fig. 12.

BETULITES SNOWII, sp. nov.

Pl. V, Figs. 1–4.

Leaves larger, subcoriaceous, long-petioled, rhomboidal-ovate in outline, pointed at apex, broadly cuneate at base, deeply, sharply, unequally dentate; secondaries oblique, straight, or the lowest pairs slightly curved backward.

These beautiful leaves, still of the same type as those of the preceding species, differ really not only in their larger size and the greater length of the petiole, but in the mode of the divisions of the borders, which are cut into unequal, longer, more acute teeth, separated by deeper, half-round sinuses. The petiole, as seen in Pl. V, Fig. 1, is slender, 6^{cm} long, and the leaf 10^{cm} long and 7^{cm} broad. In the specimens sent for examination by the Museum of the University of Kansas a number of leaves of the same size, form, and characters have been observed.

Habitat: Ellsworth County, Kansas. Nos. 593, 771, 346 and 290 of the museum of the University of Kansas; E. P. West, collector.

BETULITES POPULIFOLIUS, sp. nov.

Pl. VI, Figs. 1, 2.

Leaves large, coriaceous, long-petioled, cordate or ovate in outline, pointed at apex, truncate at base and deflexed to the petiole, regularly denticulate; secondaries deep and strong, parallel and equidistant, the lowest pair opposite and ramose.

One of the leaves, which is 7^{cm} long and as broad below the middle, has a petiole 5.5^{cm} long; the other is small, rather ovate, inequilateral, but appears identical, especially on account of the thickness of the secondaries. But both are really of the same type and have the essential characters of those described under the name of *Betulites Westii*. The appearance is, however, far different. The texture is thicker, the nervation stronger, and the border teeth are all equal and equidistant. By the divisions of the borders the leaves are related to species of Grewiopsis, especially to *G. Haydenii* Lesq.,[1] and also to a peculiar form of *Platanus Newberriana* Heer.[2] Fig. 2 is even like other forms of Betulites. Its shape as well as its nervation is remarkably similar to that of *Betula vetusta* Heer[3] of the Patoot Flora.

Habitat: Ellsworth County, Kansas. No. 6 of the collection of the museum of the University of Kansas. Collected by A. Wellington.

[1] Cret. Fl., p. 97, Pl. III, Figs. 2, 4; Pl. XXIV, Fig. 3.
[2] Fl. Foss. Arct., vol. 7, Pl. LIX, Fig. 6.
[3] Fl. Foss. Arct., vol. 7, Pl. LV, Figs. 7, 7a.

BETULITES RUGOSUS, sp. nov.

Pl. VI, Figs. 3–5.

Leaves ovate, truncate at base, round-pointed at apex, denticulate on the borders, rugose on the surface from the close, thick nervilles.

This form, which answers to the variety *oblongus* of *B. Westii*, differs from it in the distinctly more deeply denticulate borders and the coarse surface of the leaves.

Habitat: Ellsworth County, Kansas. Nos. 69 and 69a of the museum of the University of Kansas; A. Wellington, collector.

BETULITES DENTICULATUS Heer.

Phyll. Crét. du Nébr., p. 15, Pl. IV, Figs. 5, 6.

STIPULES OF BETULITES.

Pl. V, Fig. 18.

Stipules of small size, formed by the enlarging base of the petiole, rarely found attached to it, appearing, when separate, as minute leaflets cut from the middle into two pointed, obliquely diverging, acute lobes, which are cuneate at the truncate base.

As the fragments of the small organisms described above were discovered at the same locality where the leaves of Betulites were most abundant, I fancied that in their size and form they had some affinity to the trilobate, obtuse bracts of flowers of Betula, admitting this as a kind of presumptive evidence of the relation of the leaves to the Betulaceæ. Just now, and when ready to deliver the manuscript to the printer, I have received, through the kindness of Prof. F. H. Snow, a specimen of a fine leaf of Betulites with the petiole entirely preserved, enlarging at its base into a stipule (Pl. V, Fig. 18) like those described above, which had all been found separate from their support. In the form and mode of attachment to the enlarging base of the petiole these appendages are indeed in their characters similar to the stipules of the leaves of some species of Viburnum; for instance, *V. lantanoides* Michx. This fact, in opposition to the reference I have proposed for the vegetable remains described above, is on the other hand in harmony with the opinion of the Marquis de Saporta, who writes that he is disposed to refer to Viburnum a number of leaves of the same kind sent him by Prof. F. H. Snow. As he says, he has figured and described the leaves for a new work soon to be published, in which certainly the definite determination of these plants and the affinities of their characters will be satisfactorily discussed.

PHYLLITES BETULÆFOLIUS Lesq.

Cret. Fl., p. 112, Pl. XXVIII, Figs. 4-7.

Order MYRICACEÆ.

MYRICA ASPERA, sp. nov.

Pl. II, Fig 11.

Leaves coriaceous, linear-lanceolate, slightly falcate; narrow, cuneiform and entire at base, crenulate-dentate above; median nerve thick; secondaries strong, curved in traversing the blade, simple or forking at the apex; surface rough.

Two specimens represent the species. The best preserved and largest leaf figured is 8.5^{cm} long, and 2^{cm} broad. The nervation appears mixed, camptodrome and craspedodrome.

The species is related to *M. thulensis* Heer[1], two small fragments of leaves with separate seeds doubtfully referred to the species and comparable also to *M. cretacea* Heer from Quedlinburg. Its more marked affinity to living plants is with *M. cerifera* L., allied as it is to it by form of leaves and nervation.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4094a of the collection of Mr. R. D. Lacoe.

MYRICA SCHIMPERI, sp. nov.

Pl. II, Fig. 12.

Leaves coriaceous, entire, linear-oblong, obtuse, gradually narrowed to a short petiole and slightly decurrent at base; median nerve strong, percurrent; secondaries thin, camptodrome.

The leaf, 8^{cm} long with its petiole less than 1^{cm} long, is 17^{mm} broad above the middle and has a surface quite smooth and with the thin secondaries curved upward, of varying length, all opposite, diverging 35° to 40° from the median nerve. It has the same kind of nervation as *M. emarginata*, described below, and might be referred to this species but for the obtuse

[1] Fl. Foss. Arct., vol. 3, pt. 2, p. 107, Pl. XXXI, Fig. 1.

apex of the leaf. The secondaries are thin, opposite, and at the same relative distance.

Habitat: Four miles southwest of Brookville, Kansas. No. 4195 of the collection of Mr. R. D. Lacoe.

MYRICA EMARGINATA Heer.
Pl. XII, Fig. 1.

Heer, Fl. Foss. Arct., vol. 6, 2 Abth., p. 66, Pl. XLI, Fig. 2; Pl. XLVI, Fig. 12e.

Leaves oblong, quite entire, emarginate at apex, gradually narrowed to the base; secondaries thin, camptodrome, the lower pairs only opposite.

This leaf has the same characters as that represented by Heer (loc. cit., Fig. 2), being only slightly larger and better preserved, the base only being destroyed. It is 6^{cm} long, a little more than 2^{cm} broad in the upper part, and with seven pairs of secondaries, curved in passing towards the borders at an angle of divergence of 40°. The texture is subcoriaceous. Its close relation to *M. Schimperi* has been remarked above.

Habitat: Ellsworth County, Kansas. No. 672 of the museum of the University of Kansas; E. P. West, collector.

MYRICA LONGA Heer.
Pl. III, Figs. 1-6.

Proteoides longus Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 110, Pl. XXXI, Figs. 4, 5; Pl. XXIX, Fig. 8b; ibid., vol. 6, 2 Abth., p. 65, Pl. XVIII, Fig. 9b; Pl. XXIX, Figs. 15-17; Pl. XXXIII, Fig. 10; Pl. XLI, Figs. 4b, d.

Leaves coriaceous, linear, attenuated to the base, obtuse at the apex, entire; secondaries very thin.

The characters are in accordance with the description and figures of Heer as above. The secondaries are obliquely curved in passing through the blade and are extremely thin and difficult to perceive. Fig. 3 agrees with that in Fl. Foss. Arct., vol. 3, pt. 2, Pl. XXXI, Fig. 4, which has the leaves linear, of the same width and somewhat curved, while Fig. 1, and more especially Fig. 2, has the same characters as that in Fl. Foss. Arct., vol. 6, 2 Abth., Pl. XXIX, Fig. 15, the leaves being a little more enlarged in the middle and narrowed upward and downward in the same degree. Fig. 6 has the same form and size as Heer's Fig. 8b, Pl. XXIX (loc. cit).

Habitat: Ellsworth County, Kansas. Nos. 701, 711, 714, and 718 of the museum of the University of Kansas. Collected by E. P. West.

MYRICA OBLIQUA, sp. nov.[1]

Pl. XLIV, Fig. 16.

Leaf subcoriaceous, smooth on the surface, entire, small, oblanceolate or gradually narrowed from the obtuse apex and decurring at base to a short petiole; midrib broad; secondaries very oblique, camptodrome.

The leaf is 3.5^{cm} long, 11^{mm} broad in the upper part, and is similar to the small leaf of *M. Studeri* Heer, figured in Fl. Tert. Helv., vol. 2, Pl. LXX, Fig. 21, as well in form and size as in nervation. It also resembles *M. bilinica* Ett. (Foss. Fl., Bilin, pt. 1, p. 43, Pl. XIV, Fig. 3).

Habitat: Ellsworth County, Kansas. No. 1144 of the collection of Mr. R. D. Lacoe.

MYRICA OBTUSA Lesq.

Cret. Fl., p. 63, Pl. XXIX, Fig. 10.

MYRICA DAKOTENSIS Lesq.

Cret. and Tert. Fl., p. 35, Pl. IV, Fig. 9.

MYRICA CRETACEA Lesq.

Hayden's Ann. Rept., 1874, p. 339, Pl. III, Fig. 4.

MYRICA STERNBERGII Lesq.

Cret. and Tert. Fl., p. 35.

MYRICÆ? SEMINA Lesq.

Cret. Fl., p. 63, Pl. XXVII, Figs. 4, 4a.

Order JUGLANDEÆ.

JUGLANS ARCTICA Heer.

Pl. XIX, Fig. 3; Pl. XXXIX, Fig. 5.

Heer, Fl. Foss. Arct., vol. 6, 2 Abth., p. 71, Pl. XL, Fig. 2; Pl. XLI, Fig. 4c; Pl., XLII, Figs. 1–3; Pl. XLIII, Fig. 3.

Leaves thickish, subcoriaceous, with rough surface, oblong-lanceolate, tapering to the apex, rounded and narrowed to the short petiole, quite entire,

[1] This species was named "*Myrica proxima*, sp. nov.," by Prof. Lesquereux, but this species is preoccupied by the *Myrica proxima* of Ettingshausen (Beiträg. z. Kennt. d. Foss. Fl. Neuseelands, Denkschr. d. math. naturwissensch. cl. d. k. Akad., Wien, vol. 52, 1887, p. 159, Pl. IV, Fig. 14). It therefore becomes necessary to change it, and I have called it *Myrica obliqua*.—F. H. K.

inequilateral; median nerve stout; secondaries simple, camptodrome, curved in passing toward the borders, which they follow in a simple series of areoles; nervilles thick, distant, simple or forking, and anastomosing in the middle.

The leaves are about 11^{cm} long and 3.5^{cm} broad below the middle. The nervation is strongly marked; the secondaries, of which there are from ten to twelve pairs, curve from the median nerve and near their base still more strongly than toward the borders, which they follow in a series of long festoons.

Comparing this leaf to those in Heer's Fl. Foss. Arct., vol. 6, 2 Abth., Pl. XLII, Figs. 1, 2, the identity appears fully established. Two of the leaves figured by Heer (loc. cit., Pl. XLI, Fig. 4c, and Pl. XLII, Fig. 1), are inequilateral or larger on one side than on the other, and the nervation, especially in Figs. 1 and 2 of Pl. XLII, is of the same character, although less distinctly marked than it is in the leaves from the Dakota Group. Heer refers to this species a large, round nut (loc. cit., XLII, Fig. 3), evidently a Juglans.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4104 of the collection of Mr. R. D Lacoe. No. 859 of the museum of the University of Kansas.

JUGLANS CRASSIPES Heer.
Pl. XLIX, Figs. 1-3.

Heer, Fl. Foss. Arct., vol. 7, p. 27, Pl. LXI, Fig. 4; Pl. LXV, Fig. 9.

Leaves large, membranous, elliptical-lanceolate, quite entire; midrib thick; secondaries distant, very thin and much curved, camptodrome.

The three leaves referred to the species of Heer agree with the description and the figures given by the author (loc. cit.). Figs. 1 and 3 of our plate agree, especially in the form of the leaves and the nervation, with Heer's Fig. 4, Pl. LXI, while Fig. 2 has the midrib and petiole quite as thick as that of Heer's Fig. 9, Pl. LXV. The Dakota Group leaves, especially the two first mentioned, agree still more closely with the figure given of the species in Heer (Fl. Von Moletein, p. 23, Pl. VI, Fig. 3), which the author compares to *J. acuminata* Al. Br., of the Miocene. They still more closely resemble those of *J. Ungeri* Heer (Fl. Tert. Helv., vol. 3, Pl. CLV, Fig. 18). being larger than any of those of *J. acuminata*. The secondaries of this species are thin, especially in comparison to the size of the midrib.

Habitat: Near Fort Harker, Kansas. The three specimens here figured are all numbered 2748 in the U. S. National Museum Catalogue.

JUGLANDITES PRIMORDIALIS, sp. nov.
Pl. XXXV, Fig. 15.

Leaves subcoriaceous, entire, oblong-lanceolate, apparently acute (point broken), rounded in narrowing to the base, inequilateral; secondaries thin but distinct, nearly at right angles to the median nerve, parallel, camptodrome, curving at a distance from the borders and joined in bows by anastomosing with each other or with intermediate tertiaries.

This leaf, which is about 8^{cm} long, is curved in the middle and is broader on one side. It has no affinity to any species from the Cretaceous, but is related to leaves from the Miocene, being especially similar to those of *Juglans dubia* Ludw., figured in Palaeontographica, vol. 8, p. 140, Pl. LIX, Figs. 1, 2, and to those of some varieties of *J. acuminata* Al. Br.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4096b of the collection of Mr. R. D. Lacoe.

JUGLANDITES ELLSWORTHIANUS, sp. nov.
Pl. XXXVII, Fig. 1.

Leaflets large, coriaceous, oblong-lanceolate, rounded and slightly unequal at base, penninerved; median nerve thick; secondaries oblique, simple, arched near the borders and following them in simple areoles; nervilles at right angles, anastomosing with the thin tertiaries, intermediate and parallel to the secondaries.

The genus Juglandites of Sternberg has been emended and admitted by Saporta for the description of leaves or rather leaflets having a likeness to those of Juglans by their form, the unequal base of the leaves, and the nervation. These leaves, says the author, which are found abundantly at Sézanne, generally have the borders slightly denticulate. The leaflet described above and those of the following species have all the characters of Juglandites, except that the borders are perfectly entire. This difference does not eliminate them from that generic division, for even the species described by Saporta as *Juglandites peramplus*[1] shows a leaflet larger but similar in form and nervation to our Fig. 1, Pl. XXXVII, and is represented with entire, somewhat undulate borders.

The specimen from Kansas bears the impression of a thick pinnule

[1] Fl. Foss. Sézanne, p. 418, Pl. XIV, Fig. 7.

with borders entire, slightly undulate, 11^{cm} long from the base to near the taper-pointed apex (destroyed), and 5^{cm} broad below the middle. The secondaries are strong, parallel, equidistant, diverging from the median nerve at an angle of 50°, nearly straight to above the middle, then curving in bows which follow quite near the borders, anastomosing in simple areoles. The leaf is comparable also to species of Apocynophyllum and of Rhamnus, especially *R. Eridani* of the Miocene of Europe, which, like Juglans, appears first in the Cenomanian and becomes abundantly represented in the Upper Cretaceous and Lower Tertiary.

Habitat: Ellsworth County, Kansas. No. 782 of the collection of the museum of the University of Kansas; E. P. West, collector.

JUGLANDITES SINUATUS, sp. nov.

Pl. XXXV, Figs. 9–11.

Leaflets large, ovate-lanceolate or lanceolate, more or less rapidly narrowed in rounding to the base, subfalcate, entire; median nerve strong; secondaries close, camptodrome; nervilles thin, close, simple or forking at the middle, oblique to the secondaries, sparingly branching.

The surface of these leaves is distinctly undulate, the lamina becoming prominent or inflated between the lateral nerves. These emerging from the median nerve at an angle of 50° to 60° run straight toward the borders, where they abruptly curve quite near the margin, being mostly simple, but traversed by thin, oblique nervilles. The leaves are 9^{cm} to 12^{cm} long or more, none being preserved entire. As seen from the fragment (Fig. 11) the apex is obtuse, but this fragment has the secondaries more distant, more distinctly ramose, and although the nervilles are of the same character it may represent another species. Fig. 9 seems, by its curve to one side, to be a lateral leaflet of a compound leaf. I have, however, from Mexico, specimens of a species of Rhamnus as yet undetermined, whose leaves are very similar in character to those described above, some of them being falcate, as in Fig. 9.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4086 of the collection of Mr. R. D. Lacoe.

JUGLANDITES LACOEI, sp. nov.

Pl. XLVIII, Fig. 5.

Leaflets small, linear-oblong, rounded in narrowing to the base or short petiole, obtuse and abruptly short acuminate; borders entire; midrib deep and narrow; secondaries numerous, curved, camptodrome.

There is only one leaflet, 5^{cm} to 6^{cm} long, 2^{cm} broad between the parallel borders, with thirteen pairs of secondaries joining the midrib at a broad angle of divergence of 60°, then running upward and following the borders in simple festoons, parallel and equidistant.

Habitat: Kansas.

Order PLATANACEÆ.

PLATANUS PRIMÆVA Lesq.

Pl. VIII, Figs. 7–8b; Pl. X, Fig. 1.

Cret. Fl., p. 69, Pl. VII, Fig. 2; Pl. XXVI, Fig. 2.

Leaves large, palmately trilobate, broadly rhomboidal in outline, deeply, distantly dentate; lateral lobes simple, short; nervation platanoidal, tripalmate; lateral primaries suprabasilar.

This species is now represented by a large number of specimens. Among others a very large one is covered with fragments of four leaves, one of which is represented on Pl. X, Fig. 1, and another, on Pl. VIII, Figs. 8–8b, smaller, but nearly entirely preserved with its petiole and a raceme of flowers, which I consider as referable to this species. In all the leaves examined, one of which, the largest, is 17^{cm} long and more than 20^{cm} between the extremities of the lobes, the lobes are more or less distinct, in none, however, less than in Pl. VIII, Fig. 7, and always distinctly, distantly dentate. In this last specimen the lobes and the teeth appear blunt; but the border of the leaf is somewhat eroded on account of the softness of the sandstone and probably the teeth are rendered obtuse by obliteration. The base of the leaves is also generally more prolonged downward, descending far below the primary lateral nerves, or lower than observed formerly in the specimens figured in my Cretaceous Flora. But this character is of no importance, as the same differences are commonly remarked on the leaves of the living *P. occidentalis* L., to which the fossil ones are remarkably similar in form and size. Indeed, comparing the leaves of *P. primæva* of the Dakota Group with those of *P. Haydenii* of the Laramie, those of *P. Guillelmæ* of the Miocene, those of *P. appendiculata* of the auriferous gravel deposits of the old Pliocene of California, and those of the living *P. occidentalis*, one sees the original type so clearly and distinctly preserved that, overlooking the great differences of age, it would be difficult to separate these leaves into different species.

The flower heads are small, deeply embedded in the stone, the diameter of those exposed at the surface being only 6^{mm} to 7^{mm}, the rays short, the nucleus 3^{mm} to 4^{mm}.

Habitat: From ten miles northeast of Delphos, Kansas. Locally found in abundance. The best specimens are Nos. 4001 and 4002 of the collection of Mr. R. D. Lacoe.

PLATANUS PRIMÆVA Lesq. var. GRANDIDENTATA.

Pl. IX, Figs. 1, 2.

Leaves coriaceous, palmately trilobate, broadly cuneate and entire at base, deeply, sharply dentate on the border; nervation trifid; lateral primaries suprabasilar, parallel to the secondaries, branching; secondaries rigid, mostly simple, passing straight to the point of the teeth.

The leaf (Fig. 1), like those of the following variety, is of medium size. The lateral lobes are prolonged outside at the same degree of divergence as the secondaries, 35° to 40°, and are lanceolate, acuminate, sharply dentate on both sides. The nervilles at right angles to the nerves are strong, flexuous, parallel, entire or forking, platanoidal in their divisions.

Habitat: Ellsworth County, Kansas. Nos. 744 and 869 of the collection of the museum of the University of Kansas. Collected by E. P. West.

PLATANUS PRIMÆVA Lesq. var. SUBINTEGRIFOLIA.

Pl. IX, Figs. 3, 4.

Leaves coriaceous, round, oval or oblong, obtuse, short petioled, dentate all around except at the subcordate base; primary nerve thick; secondaries oblique, parallel, ramose; nervilles very strong; areolation of *Platanus primæva*.

The leaves of this variety are not lobate but merely dentate all around, except at the base; the teeth are short, turned outside, and are entered by the ends of the secondaries and of their divisions and separated by flat or shallow sinuses. The secondaries are much branched outside, the tertiary divisions generally forking again near the border. The leaf (Fig. 4) is smaller, oblong, apparently obtuse, the apex being destroyed. The secondaries are less ramose, the lowest pair only being divided on the lower side in paralled curved tertiaries, the others merely forking near the borders. The characters of these two leaves, though their size and form differ, are the same.

Habitat: Ellsworth County, Kansas. Nos. 763 and 764 of the collection of the museum of the University of Kansas; E. P. West, collector.

PLATANUS PRIMÆVA Lesq. var. INTEGRIFOLIA.

Pl. XLIX, Fig. 4.

The leaf is very small, the borders quite entire and the secondaries are of the same character as those of *P. primæva* Lesq.

It seems to be merely a young, not entirely developed, leaf of the same species.

Habitat: Near Fort Harker, Kansas. No. 2730 of the U. S. National Museum.

PLATANUS OBTUSILOBA Lesq.

Pl. X, Fig. 2.

Cret. Fl., p. 69, Pl. VII, Figs. 3, 4.

Leaves small, palmately, irregularly trilobate; lobes short, obtuse; borders undulate; primary nerves three to five, palmate from above the basal border of the long petiole.

The leaf figured here agrees on the whole with the above short diagnosis of the species and is surely correctly referred to it. It differs merely in the apparent texture of the leaf, which, although polished on the surface, seems rather membranous and not very thick. The lateral primary nerves are not opposite, a difference which is not of specific value, as in both figures of the species (loc. cit., Pl. VII, Figs. 3, 4) one of the leaves is normally nerved, while the other has four primary nerves diverging from the same point and one of a lower degree placed far below, nearly as strong as the primary ones. The borders are also less undulate and the secondaries are rather camptodrome than craspedodrome, some of them forking quite near the borders, the divisions passing upward and running onto the borders or along them.

The species is very rare and distinctly characterized. It has not before been found in Kansas.

Habitat: Near Carneiro, Ellsworth County, Kansas. No. 54 of the collection of the University of Kansas. Collected by E. P. West.

PLATANUS NEWBERRIANA Heer.

Phyll. Crét. du Nébr., p. 16, Pl. IX, Fig. 3; Lesquereux, Cret. Fl., p. 72, Pl. VIII, Figs. 2, 3; Pl. IX, Fig. 3.

PLATANUS HEERII Lesq.

Cret. and Tert. Fl., p. 44, Pl. III, Fig. 1; Pl. VII, Fig. 5; Cret. Fl., p. 70, Pl. VIII, Fig. 4; Pl. IX, Figs. 1, 2.

PLATANUS DIMINUTIVA Lesq.

Cret. Fl., p. 73, Pl. VIII, Fig. 5.

PLATANUS CISSOIDES, sp. nov.[1]

Pl. LXI, Fig. 3.

Leaf of medium size, subcoriaceous, ovate, five lobate, rounded to the base in narrowing to the petiole, blunt-pointed at apex; primary nerves, three, the lateral joined to the midrib far above the base of the leaf, obliquely diverging and passing up to the point of the lobes; secondaries, two pairs, distant from the primaries, passing up to the borders under the same angle of divergence and parallel; tertiaries at right angles to the midrib or oblique as branches of the secondaries; areolation obsolete.

The leaf is somewhat like that of Platanus, though its appearance is different, especially in its having few entire lobes. The angle of divergence of the lateral primaries is 40°, and as they curve upward the lobes are in the upper part of the leaves as well as the few secondaries, of which there are only two pairs, and the leaf is more like that of a Cissus. It is, however, forcibly referable to Platanus, being closely allied to *P. Heerii* Lesq., as figured in Cret. Fl., p. 70, Pl. IX, Fig. 2, from which it differs essentially by the blunt-pointed lobes, the few secondaries, and the narrow form of the leaf.

Habitat: Near Fort Harker, Kansas. No. 2736 of the U. S. National Museum.

LIQUIDAMBAR INTEGRIFOLIUM Lesq.

Cret. Fl., p. 56, Pl. II, Figs. 1, 3; Pl. XXIV, Fig. 2. Cret. and Tert. Fl., p. 45, Pl. XIV, Fig. 3.

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[1] This species was described and figured in the manuscript under the name of *Phyllites cissoides*, but in a list of Dakota Group plants purchased for the U. S. Geological Survey, and sent by Prof. Lesquereux only a few weeks before his death, this type specimen is labeled *Platanus cissoides*. He has pointed out in the description that it is like Platanus and closely allied to *P. Heerii* Lesq., and it seems more than probable that he intended to change it to this genus and neglected actually to do so. I have therefore ventured to transfer it from its somewhat unmeaning position under Phyllites to the more definite position under Platanus.—F. H. K.

Order URTICACEÆ.

Tribe ARTOCARPEÆ.

Subtribe FICEÆ.

FICUS MACROPHYLLA, sp. nov.
Pl. XI, Fig. 1.

Leaf very large and entire, coriaceous, polished on the surface, oblong-lanceolate, moderately curved in narrowing to the petiole, apparently obtuse (base and apex destroyed), penninerved; median nerve very thick; secondaries numerous, alternate, nearly at right angles, undulate, forking in the middle or above, curving and anastomosing at a distance from the borders in double or repeated bows, separated by tertiary, thinner nerves, the areas being covered by large, square areoles formed by nervilles at right angles to the nerves.

Though lacerated the leaf shows its size to be at least 30^{cm} in length, 10^{cm} in width below the middle. The nervation as well as the large areoles formed by the nervilles in joining the intermediate tertiary nerves at right angles are deep and quite distinct. By its nervation, at least, the leaf is comparable to that of *F. rectinervis* Ett.,[1] which, however, is of a different form. But it is has a greater degree of affinity to a living as yet undetermined species, of which Prof. von Ettingshausen has reproduced the impression of a leaf,[2] remarking that the plant is cultivated in the garden of Schoenbrunn, Vienna. The essential characters of both the fossil and the living leaves are the same, except that the fossil leaf is somewhat larger.

Habitat: Near Fort Harker, Kansas. No. 60 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

FICUS GLASCOENA Lesq.
Pl. XIII, Figs. 1, 2.

Cret. and Tert. Fl., p. 48.

Leaves large, thick, coriaceous, polished on the surface, oblong-lanceolate, obtusely pointed, narrowed in a curve and declining to the petiole; median nerve very broad, secondaries thin, at a broad angle of divergence,

[1] Foss. Fl. Sagor, pt. 1, Pl. VIII, Fig. 17.
[2] Foss. Fl. Bilin, pt. 1, Pl. XIX, Fig. 4.

scarcely curved in passing to the borders, joining by abrupt curves, or without curving to it, a somewhat thick, marginal nerve.

The species is represented by many fragments of leaves, one of them 20^{cm} long, 7.5^{cm} broad below the middle. The nervation is of the type of *F. multinervis* Heer, or *F. parasitica* Schott, this last figured by self-impression in Foss. Fl. Bilin, pt. 1, Pl. XXIII, Fig. 1. Compared to fossil species of the Cretaceous of Greenland, it is like *F. protogæa*[1], or *F. atavina* Heer[2]. From this last species it differs essentially by the large size of the very thick leaves, is more rapidly narrowed to the base and the lateral nerves, sometimes forking above the middle, abruptly anastomosing with a thick, marginal nerve, which follows close to the borders, even apparently forming the borders and thus generally obsolete; for often this nerve appears as the impression of the narrowly recurved margin. In the living species of Ficus of this type, this marginal nerve is often scarcely perceivable, and thus is very rarely observed in the fossil leaves. The angle of divergence of the nerves is about 60°.

Habitat: Two and one-half miles south of Glascoe, Kansas. Nos. 478 and 532a of the Museum of Comparative Zoology of Cambridge, Massachusetts.

Ficus proteoides, sp. nov.

Pl. XII, Fig. 2.

Leaves very long, coriaceous, entire, lanceolate, broadest in the lower part, gradually narrowed upward and gradually tapering to an obtuse apex, more rapidly narrowed toward the petiole; primary nerve strong, secondaries alternate, very thin, partly obsolete, curved in passing toward the borders, camptodrome.

The leaf, by its form at least, is much like those of *Ficus elongata* Hosius.[3] It is, however, longer, especially differing by the much thinner secondaries being far more curved, and by a petiole only half as long. The leaf is nearly 22^{cm} long, 3^{cm} broad at its broadest part 6^{cm} above the base, and with a petiole 2^{cm} long. The thin secondaries are a little more open than in *F. Berthoudi* Lesq., more curved in traversing the blade and shorter, or not ascending high along the border. It differs also from it by being enlarged nearer to the base, its borders rounding somewhat in

[1] Fl. Foss. Arct., vol. 3, pt. 2, p. 108, Pl. XXX, Figs. 1–8.

[2] Loc. cit., vol. 6, 2 Abth., p. 69, Pls. XI, XVII, XX, etc.

[3] Dicotyl. der westf. Kreideform., p. 98, Pl. XIV, Fig. 15.

reaching the petiole, which are not decurrent to it, and by the obtuse apex. Everything considered the leaf is much like *Proteoides daphnogenoides* Heer, as figured in my Cret. Fl., Pl. xv, Fig. 1. The leaves of this species are merely smaller, the median nerve much thinner and the secondaries totally obsolete. The species has also a marked degree of relation to *Ficus Falconieri* Heer,[1] from the Miocene of England.

Habitat: Ellsworth County, Kansas. No 853 of the museum of the University of Kansas; E. P. West, collector.

FICUS BERTHOUDI, sp. nov.

Pl. XII, Fig. 3.

Leaves long, lanceolate, tapering upward from the middle to an acute point, gradually narrowed to the base; primary nerve thick in its lowest part, becoming narrow above the middle; secondaries very oblique, distinct, alternate, parallel, curved in traversing the blade, following the borders in long bows.

The leaf is 18^{cm} long, 4^{cm} broad in the middle, not of very thick substance, being subcoriaceous. The primary nerve is much enlarged from the middle to near the base; the lower secondaries are more oblique, 35° of divergence, slightly inclined downward in reaching the midrib, and follow the borders in long curves, while the upper ones, a little more open, 40° of divergence, curve and anastomose along the borders in simple, osculating bows; the nervilles are very thin at right angles to the secondaries, and mostly simple.

In form and type of nervation the leaf is related, like the preceding one, to *Ficus elongata* Hosius (loc. cit.), from which it essentially differs in being largest in the middle and gradually narrowed upward and downward in the same degree, the leaves of *F. elongata* being broadest above the base and rounded in narrowing to the petiole, which they reach in a curve and not decurrently; also by the secondaries being more approximate in the upper part of the leaf, the lower more oblique, curving higher along the borders; and finally, by the thinner substance of the leaves.

This peculiar section of Ficus is represented in the Senonian Flora of Westphalia by at least six species, and by two others in that of the Cenomanian of Moletein, one of which, *F. Mohliana* Heer, is also closely related to *F. Desori* Heer. It is therefore not surprising to find in the Dakota Group a

[1] Fl. of Bovey-Tracy, Phil. Trans., vol. 152, pt. 2, p. 1060, Pl. LXIII, Fig. 1a; Pl. LXIV, Figs. 6, 7; Pl. LXVI, Fig. 4.

number of leaves referable to the same type which remains predominant in the Tertiary.

Remark.—Ficus Berthoudi is not always enlarged in the middle but has its leaves sometimes linear. In No. 463a of Sternberg's collection the leaf is narrowed to the petiole which is curved and of the same size as *F. proteoides* (Pl. XII, Fig. 2), except that the leaf is linear above the basal part, being 3^{cm} in diameter in the middle, and 2.5^{cm} in the upper and lower parts. The direction of the secondaries is the same as in Fig. 3, but they diverge in the lower part, being more open in the upper.

Habitat: Ellsworth County, Kansas. No. 856 of the museum of the University of Kansas. Collected by E. P. West.

Ficus crassipes Heer.

Pl. XIII, Fig. 3.

Fl. Foss. Arct., vol. 6, 2 Abth., p. 70, Pl. xvii, Fig. 9a; Pl. xxiv, Figs. 1, 2; Pl. xlii, Fig. 2c: Pl. xliii, Figs. 4–6; Pl. xlvi, Fig. 15.

Leaves coriaceous, broadly linear-lanceolate, tapering and decurrent to the base, quite entire; median nerve thick; secondaries obsolete; petiole long and thick.

This species, represented by Heer (loc. cit.) by many leaves, which are more or less well preserved but none entirely so, is easily recognized by the basilar form of its leaves, which are gradually narrowed and narrowly decurrent to a thick, median nerve, thus forming a thick or broad-winged petiole. As yet I have seen only the specimen figured, showing a little more than half a leaf, its lower part, of which the secondary nervation is totally obsolete. The nervation and areolation as figured by Heer (loc. cit., Pl. xlvi, Fig. 15), is in thin, irregular areoles, like those of *F. atavina* Heer, to which this species has great affinity, as well as by the form and size of its leaves.

Habitat: Ellsworth County, Kansas. No. 100a of the collection of the museum of the University of Kansas; A. Wellington, collector.

Ficus magnoliæfolia Lesq.

Pl. XVI, Fig. 4.

Cret. and Tert. Fl., p. 47, Pl. xvii, Figs. 5, 6.

The leaf is of the same character, only slightly smaller, as the type specimens which were collected in Colorado at the base of the Rocky

Mountains, where the older strata covering the primary rocks are nearly vertically upheaved and their edges locally exposed to view. From western Kansas the Dakota Group is covered by Upper Cretaceous and Tertiary strata; its continuity is thus proved by the identity of the plants found both in Colorado and Kansas.

Habitat: Ellsworth County, Kansas. No. 815 of the collection of the museum of the University of Kansas.

FICUS BECKWITHII Lesq.

Cret. and Tert. Fl., p. 46, Pl. XVI, Fig. 5; Pl. XVII, Figs. 3, 4.

FICUS HALLIANA Lesq.

Cret. Fl., p. 68, Pl. XXVIII, Figs. 3–9.

FICUS PRIMORDIALIS Heer.

Phyll. Crét. du Nébr., p. 16, Pl. III, Fig. 1; Lesquereux, Cret. and Tert. Fl., p. 45.

FICUS ? ANGUSTATA Lesq.

Cret. and Tert. Fl., p. 47.

FICUS DEFLEXA, sp. nov.

Pl. III, Fig. 13; Pl. XVI, Fig. 3.

Leaves small, very thick, coriaceous, entire, broadly oval, rounded at the petiole and abruptly declined to it; pointed at apex; primary nerves stout; secondaries thick, camptodrome; petiole gradually thickened to its base.

The leaves are small, about 4^{cm} long, 3^{cm} broad, with three to four pairs of strong, parallel, opposite secondaries and a thin basilar one, all much curved in passing to the borders and along them, following them in areoles; nervilles thick, at right angles to the nerves and generally forking at the middle.

I do not know of any fossil species to which these leaves are strictly comparable. But they are quite similar to those of *F. bengalica (F. bengalensis* L.?*)* of which a leaf is reproduced by impression in Ettingshausen's Flora of Bilin, Pl. XXVI, Fig. 1. There is a difference only in the position of the lowest pair of primaries, which in the living species are derived from the top of the petiole with the lower pair of secondaries at a great distance above, while in the fossil leaves the lowest pair of primaries are supra-basilar and parallel to the secondaries. Although this difference is marked, the type of nervation is the same for these leaves, being that of the palmately trinerved section of the genus. The petiole is 18^{mm} long, thick and much enlarged at the base.

Habitat: Ellsworth County, Kansas. Nos. 812 and 821 of the collection of the museum of the University of Kansas. Collected by E. P. West.

FICUS PRÆCURSOR, sp. nov.

Pl. XLIX, Fig. 5.

Leaves of medium size, long-petioled, enlarged at the middle, constricted and taper-pointed above, narrowed to the base, entire; midrib strong, precurrent; secondaries numerous, parallel, curved, camptodrome; nervilles distant, simple or rarely branching at the middle.

There are two leaves of this species. The one figured is 7^{cm} long with a petiole preserved which is 1^{cm} long, 3.5^{cm} broad at the enlarged part (the middle), and has nine or ten pairs of secondaries at an angle of divergence of 40°. The other leaf is smaller but of the same form; its pedicel is broader than the midrib, evidently long but also broken 1^{cm} below the base of the leaf.

The leaves resemble those of *F. pulcherrima* Sap. (Études, vol. 1, p. 86, Pl. VII, Fig. 2), being less inequilateral at the base, more abruptly constricted below the less sharply pointed acumen. Saporta compares his plant to some species of tropical Asia, especially *F. tenax* of Timor.

Habitat: Ellsworth County, Kansas. Specimen No. 223 of the collection of Mr. R. D. Lacoe.

FICUS KRAUSIANA Heer.

Pl. L, Fig. 5.

Leaves large, subcoriaceous, entire, lanceolate, gradually attenuate upward from below the middle in passing to a blunt apex (destroyed) and downward to a thin, short petiole; midrib comparatively narrow; secondaries thin, oblique, running straight from the midrib to near the borders, where they abruptly curve, following them in long, flat bows.

The species is closely allied by some characters to *F. Berthoudi*, but more distinctly by others to *F. Krausiana* Heer (Flora von Moletein, p. 15, Pl. v, Figs. 3–6). From *F. Berthoudi* it differs in the thick, coriaceous leaves, apparently blunt at apex; the secondaries straight from the base to near the borders, separated by a simple intermediate tertiary. From *F. Krausiana* as figured in the Flora of Moletein it merely differs by the large size of the leaves and the narrow midrib, a difference not important enough to authorize the separation as a new species.

The leaves vary from 12^{cm} to 22^{cm} in length, and from 3^{cm} to 4.5^{cm} in breadth, the petiole being 2.5^{cm} long; the secondaries, though deeply cut into the epidermis, are very thin, parallel from the base of the leaves, diverging at an angle of 50°.

Habitat: Near Fort Harker, Kansas. No. 2706 of the collection of the U. S. National Museum.

Ficus inæqualis, sp. nov.

Pl. XLIX, Figs. 6–8; Pl. L, Fig. 3.

Leaves of the same type as those of *F. præcursor* and *F. pulcherrima*, being very unequal-sided, ovate-lanceolate, gradually acuminate, narrowed to a thick, short petiole. Midrib thin toward the apex, gradually broad toward the base; secondaries at short distances, parallel, equidistant, camptodrome.

This species differs from *F. præcursor* in the leaves being more sharply acuminate, the sides very unequal, and the petiole short and thick; the secondaries are parallel, equidistant; their angle of divergence is the same, but they do not ascend high along the borders, which they follow in close, simple festoons. The nervation is comparable to that of *F. Jynx* Ung. (Fl. von Sotzka, Pl. XII, Fig. 3). The texture is as in *F. præcursor.* The secondaries, curved and camptodrome, do not ascend as high along the borders, which they follow in simple areoles.

The leaf (Pl. L, Fig. 3) is large, less unequal-sided, and has a straight, sharply pointed acumen. It has some likeness to the leaves of *F. magnoliæfolia.*

Habitat: Near Fort Harker, Kansas. No. 2770 of the U. S. National Museum collection.

Ficus Sternbergii, sp. nov.

Pl. L, Fig. 1.

Leaves lanceolate, sharply acuminate, entire, triple nerved; incurved, lowest secondaries very long, the others shorter, arcuate.

This leaf is similar to that of *F. Aglajæ*, described by Unger in his Flora of Kumi in Eubœa, p. 29, Pl. IV, Figs. 34–36. This is, however, deprived of the petiole, and though this is the only apparent difference, it can not be identified with that of the Miocene of Eubœa. The nervation is so peculiar that the similarity is the more remarkable. The leaf does not appear very thick or coriaceous, but is solid and the surface has no trace of nervilles.

Habitat: Near Fort Harker, Kansas. No. 2809 of the U. S. National Museum collection.

FICUS MELANOPHYLLA, sp. nov.
Pl. L, Fig. 2.

Leaves coriaceous, oblong, abruptly rounded at base in passing obliquely towards the petiole and curving down in reaching it, obtuse at apex (broken), entire; secondaries numerous, parallel, oblique, generally separated by parallel tertiaries curving and joined in bows at a distance from the borders, a camptodrome and dictyodrome nervation.

This finely preserved leaf is about 5^{cm} long, 3.5^{cm} broad above its base, and has a slender petiole 1.5^{cm} long, which is enlarged at its point of attachment. I do not find any leaf to which its form is comparable; but its well defined nervation and areolation are those of many species of Ficus living in our time. *F. nitida* Thunb., *F. americana* Dubl., *F. lentiginosa* Vahl of Cuba, etc., are examples.

Habitat: Kansas.

FICUS MUDGEI, sp. nov.
Pl. XII, Fig. 4.

Leaves small, coriaceous, elliptical, obtuse at apex and at the base in joining the strong petiole, entire; nervation penninerved-camptodrome.

A small leaf, 5^{cm} long, 3.5^{cm} broad at the middle, the borders curving at base to a strong, woody petiole 2^{cm} long. The primary nerve is thin, enlarging only near the base. The secondaries consist of six pairs, which are alternate, at an angle of divergence of 45°, all equidistant, parallel, thin, curved near the borders, anastomosing in simple bows. The nervilles are thin, at right angles to the secondaries, traversed by very thin tertiaries or anastomosing at right angles.

The leaf has the appearance of a Rhamnus, and is comparable in form and size to *R. Aizoon* Ung. (Flora von Sotzka, p. 49, Pl. XXXI, Fig. 7). It differs, however, in the mode of attachment by a basilar curve to a strong petiole and also in the position of the lower secondaries, which are opposite and quite near the base of the midrib. The essential characters of the fossil species are recognized in *Ficus sycomorus* L., and in the impression of a leaf of the cultivated *F. cestrifolia* Schott, in Ettingshausen's Bilin Flora (pt. 1, Pl. XXIV, Fig. 3).

Habitat: Ellsworth County, Kansas. No. 755 of the collection of the museum of the University of Kansas. Collected by E. P. West.

FICUS? UNDULATA, sp. nov.

Pl. XII, Fig. 5.

Leaves small, subcoriaceous, deltoid, obtuse, round, truncate at base, deeply, regularly undulate; median nerve thick, rigid; secondaries thin, close together, or alternating with shorter intermediate ones, somewhat curved in the middle, camptodrome, nearly simple.

The fragment, the only one seen of this character, is of a comparatively small leaf, 5^{cm} long, 4^{cm} broad near the round truncate base, with thin secondaries parallel, at an angle of divergence of 40° to 45° from the midrib. These are nearly 5^{mm} distant at their point of attachment to the midrib, but generally separated by short, intermediate nerves of the same thickness as in the leaves of *F. atavina* Heer, a common species of the Cretaceous of Greenland.

The same type of nervation is also observed in some of the leaves of *Populus Berggreni* Heer,[1] but this last species has the leaves attenuated to the base and quite entire. Therefore the generic relation of this leaf remains somewhat uncertain.

Habitat: Ellsworth County, Kansas. No. 599 of the museum of the University of Kansas; E. P. West, collector.

FICUS ALIGERA, sp. nov.

Pl. X, Figs. 3–6.

Leaves subcoriaceous, quite entire, small, ovate or oval, obtuse or obtusely acuminate, rounded, subtruncate or narrowed to the base; petiole short, alate, constricted at its point of union with the leaves; nervation pinnate; primary nerve strong, percurrent; secondaries oblique, parallel, equidistant, camptodrome; nervilles obsolete, their base appearing at right angles to the secondaries.

The leaves vary from 2^{cm} to 5^{cm} in length and from 2^{cm} to 3^{cm} in width at or below the middle; the secondaries, at an angle of 40° to 50°, number from six to ten pairs, more or less closely placed, curve in traversing the areas, and are mostly simple or with very few branches; the petiole, 1.5^{cm} to

[1] Fl. Foss. Arct., vol. 6, 2 Abth., Pl. XVII, Fig. 8a.

2^{cm} long, 3^{mm} to 4^{mm} broad, is alate, formed by the continuation of the median nerve abruptly enlarged at the base of the leaves into a broad, flat lamina.

By the form and aspect of the leaves the species is related to *Ficus bumelioides* Ett. (Kreideflora v. Niederschoena, p. 251, Pl. II, Fig. 6), especially differing by the obtuse (not emarginate) apex of the leaves and by the foliate petiole. Its affinity, as shown by the form of the leaves, is still more marked with *Ficus Mudgei* Lesq.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4072, etc., of the collection of Mr. R. D. Lacoe.

FICUS DISTORTA Lesq.

Cret. and Tert. Fl., p. 48; Hayden's Ann. Rept., 1874, p. 342, Pl. V, Fig. 5.

FICUS LAUROPHYLLA Lesq.

Cret. and Tert. Fl., p. 49, Pl. I, Figs. 12, 13; Hayden's Ann. Rept., 1873, p. 342, Pl. V, Fig. 7.

FRUITS OF FICUS.

Pl. X, Figs. 7, 8.

Comparable to or rather much like two fruits of Ficus figured by Heer (Fl. Foss. Arct., vol. 3, pt. 2, Pl. XXX), on which he remarks (p. 109) that these fruits found with the leaves of *F. protogæa* Ett. show such a likeness to fruits of Ficus that their determination can not be doubtful. The leaves of *F. protogæa* Ett. have not yet been observed in the Dakota Group, but its flora has a large number of leaves of Ficus of the same type; *F. glascoena* Lesq., for example, differing merely from *F. protogæa* by the large size and the more ovate form of the leaves.

Habitat: Four miles southwest of Brookville, Kansas. No. 4057 of the collection of Mr. R. D. Lacoe.

FICUS LANCEOLATO-ACUMINATA Ett[1].

Pl. XIII, Fig. 4.

Foss. Flora v. Sagor, pt. 1, p. 182, Pl. VI, Figs. 3, 4.

Leaves coriaceous, polished, lanceolate, gradually acuminate, narrowed to the short petiole, entire; median nerve strong; secondaries close, curved

[1] This species was first described by Prof. Lesquereux under the name of *Laurus primigenia* Ung. var. *cretacea* Lesq., and was transferred only a short time before his death. His note is as follows: "Pl. XIII, Fig. 4, which I have referred as *Laurus primigenia cretacea*, has the same form, size of leaf, and nervation as *Ficus lanceolato-acuminata* Ett. (Flora of Sagor, Pl. VI, Figs. 3, 4). See also Engelhard, Nova Acta, vol. 43, Pl. XIV, Fig. 3 of *F. lanceolata*. Must be this, though the secondaries are a little more distant." The original description and comparisons are retained as he wrote them.—F. H. K.

upon each other near the borders, generally separated by intermediate, thinner tertiaries tending to the middle of the arches of the secondaries.

A number of the specimens of the Dakota Group represent leaves of this kind, some, however, being shorter and narrower, but all nerved as in the figure. But as the tertiaries or intermediate veins are generally obsolete, the secondaries appear sometimes more distant than they are observed in leaves of the normal form.

I am unable to find a character or a difference separating this species from that figured and described as *Laurus primigenia* by Unger and other authors, from the European Tertiary. The nervation is that of the leaves in Unger's Flora v. Kumi, Pl. VIII, Figs. 1 and 4, where the distribution of the secondaries is marked, while the intermediate tertiaries are obsolete, and Fig. 7, where the secondaries appear very close like those of our figure, from the interposition of somewhat shorter, less distinct tertiaries.

The species is common in the Miocene of Greenland. Heer has figured it in Fl. Foss. Arct., vol. 6, Abth. 1, pt. 2, Pl. III, Figs.8–13; also in Fl. Foss. Arct., vol. 7, p. 104, Pl. LXXVII, Figs. 8–13; Pl. LXXVIII, Figs. 1–11; Pl. LXXXV, Fig. 5; Pl. CI, Figs. 2–4, from the Upper Cretaceous strata of Atanekerdluk, Unartok, etc. Being thus so abundantly found in the Tertiary and Upper Cretaceous of Greenland, the presence of this species is not strange or anomalous in the Cenomanian of the Dakota Group.

The leaves of this species, though of thicker texture than those of *Laurus plutonia*, do not show the areolation as distinctly, and the secondaries are not flexuous and curve nearer to the borders. The relation, however, with *L. plutonia* is very close.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4088 of the collection of Mr. R. D. Lacoe.

ARTOCARPIDIUM CRETACEUM Ett.

Pl. L, Fig. 7.

Kreidefl. v. Niedersch., p. 251, Pl. II, Fig. 4.

Leaf petiolate, coriaceous, ovate, acuminate, entire or undulate; nervation camptodrome; primary nerve strong, percurrent; attenuate at apex; secondaries, five or six on each side, emerging at an angle of 40° to 50°, well marked, distant, the inferior proximate, the lowest supra-basilar, shorter; tertiary nerves or branches oblique.

This description agrees with that of the species by Ettingshausen in Kreideflora von Niederschoena, p. 251, Pl. II, Fig. 4. The figure given by the German author is of a mere fragment, the lower part of a leaf only, which does not show the true distribution of the secondaries. There is no reason, however, for doubting the reference of the leaf of the Dakota Group to the species.

Habitat: Near Fort Harker, Kansas. No. 2759 of the U. S. National Museum collection.

Order BALANOPHOREÆ.

WILLIAMSONIA ELOCATA, sp. nov.

Pl. II, Figs. 9, 9a.

Fragment of a cone or globose capitule, with deeply concave inside part, bordered by oppressed, oblong, lanceolate scales, bearing bristles at apex, with base of a pedicel, the point of attachment of the capitule.

I refer this fragment to Williamsonia, especially from its likeness to some figures given of the species by Nathorst,[1] which, by means of cross sections of the fruiting cones, exhibit this organism as a hollow, central axis surrounded by imbricated scales, those of the borders or of the upper part of the stem being short, imbricate, lanceolate, acute, those surrounding the hollow receptacle being longer and linear-lanceolate. The fragment from Kansas, compared to the cone (loc. cit., Pl. VII, Fig. 3) figured by Nathorst, differs merely in having the scales shorter and tipped by hairs or bristles. Although the specimen is too imperfect to offer positive points of affinity, Saporta, to whom it has been communicated, considers it as referable to the genus Williamsonia, though not exactly congener to the Williamsonia of the Jurassic, yet of a similar type which may be new, allied to the *Spadici floræ*, and at the same time analogous to that of Williamsonia.

The following is a translation of what that celebrated author writes in his Jurassic Flora, vol. 4, liv. 37, p. 122:

> We have recently received from our friend, Leo Lesquereux, another fossil organism, or rather the hollow mold of that organism, discovered in the ferruginous sandstone of the Dakota Group, therefore of the Cenomanian. One perceives in the specimen, after molding the cavity in relief, a thick, short receptacle shaped like an ovoidal, conical ball, mostly naked, and marked on its surface by scars of insertion, regularly placed in spiral, of a mass of scales, closely contiguous, inserted at right angles upon the receptacle and surrounded by a thick, spinous apophysis, subulate at base, shorter and less protruding toward the apex of the organism. These scales, which answer evidently to sexual elements, easily disengaged at maturity, are not without analogy, either by themselves or by the structure of the receptacle upon which they were implanted, with the corresponding parts of the floral spadices of

[1] Några anmärkningar om Williamsonia, Carruthers, Öfvers. k. Vet.-Akad. Förh., 1880, No. 9.

Williamsonia. If this analogy is real we would have here a sessile, naturally caducous receptacle detached after the anthesis from an involucre of which it would have occupied the center. But here, without better evidence, it is difficult to pass above simple conjecture.

He advises the publication of this fragment under a new generic name. But indeed it would be impossible to give generic characters from such a fragment, and its relation to Williamsonia being recognized, it is advisable to leave it in that genus until better specimens can afford light on the subject.

It is essentially from the presence of this organism in the Cretaceous that Saporta objects to its reference to Williamsonia, which he considers as a true Jurassic genus. But we have already a representative of another genus, *Encephalartos*, which shows, by its presence in the Flora of the Dakota Group, the same peculiar distribution as that of Williamsonia. Moreover, to do this, considering the likeness of our fragment to the fine specimen of *W. cretacea* Heer (Fl. Foss. Arct., vol. 6, 2 Abth., p. 59, Pl. XII, Fig. 1; Pl. XIII, Fig. 9), would force the elimination of this last species from the genus. I am even disposed to recognize marked degrees of affinity between the fragments figured from the Dakota Group and some of the splendid figures given by the author of the Flore Jurassique, as for example Figs. 1 and 3, Pl. CCXL, the first representing a convex tuberculose capitulum like the one seen concave by impression in our Fig. 9; the second a pedicellate capitulum like the pediceled base of our Fig. 9a. The same analogy is remarked in comparing the fragments from Kansas with the figures given by Nathorst (loc. cit., Pl. VII, Figs 1 and 3), which show, by restoration, an open capitulum with its mode and point of attachment as represented in Figs. 9, 9a.

Round or reniform in outline, 4.5^{cm} broad, 3^{cm} in vertical diameter, narrowed at the base and borne upon a cylindrical scaly branch or pedicel 1^{cm} in diameter. The scales upon the branches are short, triangular, about 1^{cm} long from their enlarged point of attachment. Those of the cone, of which the internal structure only is seen, are closely imbricated, apparently linear, flat, thickish, placed behind seeds or bearing pods which are falcate, linear, 14^{cm} long, 1.5^{mm} in diameter, transversely undulate at the surface, as in some small seeds.

Habitat: Ellsworth County, Kansas. The specimen is still in the hands of the Marquis Saporta.

Order PROTEACEÆ.

Tribe EMBOTHRIEÆ.

LOMATIA SAPORTANEA Lesq.

Hayden's Ann. Rept., 1874, p. 346; Cret. and Tert. Fl., p. 51, Pl. III, Fig. 8.
***Todea ? Saportanea* Lesq., Cret. Fl., p. 48, Pl. XXIX, Figs. 1–4.**

Correction to be made to the description of this species as given in Cret. and Tert. Fl., p. 51:

Leaves compound; leaflets opposite, more or less distant (not always connate), sometimes narrowed to the base and sessile or decurrent by a sub-base along the branches by a narrow margin. The rachis of the pinnæ is round and comparatively narrow, abruptly cut at the base of the upper pair of leaflets, or sometimes enlarged above them and terminating in a simple, lanceolate, short, and narrow pinnule, which is thus terminal and has the same character as the lateral ones. It is the same as that figured in Cret. Fl., Pl. XXIX, Fig. 4.

LOMATIA SAPORTANEA var. LONGIFOLIA Lesq.

Cret. and Tert. Fl., p. 52.

Tribe PERSOONIEÆ.

PERSOONIA LESQUEREUXII, sp. nov.[1]
Pl. XX, Figs. 10–12.

Leaves subcoriaceous, sessile or very short-pedicellate, obovate, obtuse or subemarginate at apex, gradually attenuated to the base; secondaries alternate, few, very thin, curved upward in traversing the blade at an acute angle of divergence, camptodrome.

The leaves, 3^{cm} to 5^{cm} long, 1.5^{cm} to 2.5^{cm} broad in the upper part, are narrowed to the base, slightly decurrent in reaching the short petiole and larger toward the rounded or subemarginate apex; the secondaries, three or four pairs, are parallel, much curved upward in diverging from the median nerve at an angle of 25° to 30°.

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[1] This species was named "*Persoonia Heerii*, sp. nov.," by Prof. Lesquereux in his manuscript, but as this name is preoccupied by *Persoonia Heerii* of Pilar (Fl. Foss. Susedana, 1883, p. 72, Pl. XIII, Fig. 16), it becomes necessary to change the specific name. Inasmuch as he had deemed this species worthy of bearing the name of the distinguished Heer, a compliment that the laws of nomenclature will not in this case permit to be carried out, it seems especially desirable that the compliment be returned and that it be named for himself. I have, therefore, changed the name to *Persoonia Lesquereuxii*.—F. H. K.

The species is related to *Persoonia laurina* Heer (Fl. Tert. Helv., vol. 2, p. 95, Pl. XCVII, Figs. 25–28), represented as having very obtuse leaves, rounded or slightly emarginate at apex and rapidly narrowed downward to near the base, continuing parallel to the median nerve before reaching it. Heer's Fig. 28 (loc. cit.) shows distinctly the peculiarity of form and also the same type of nervation.

Habitat: Ellsworth County, Kansas. Nos. 77c, 87, and 107 of the museum of the University of Kansas; A. Wellington, collector.

Tribe PROTEEÆ.

PROTEOIDES DAPHNOGENOIDES Heer.

Phyll. Crét. du Nébr., p. 17, Pl. IV, Figs. 9, 10; Lesquereux, Cret. Fl., p. 85, Pl. XV, Figs. 1, 2.

PROTEOIDES GREVILLEÆFORMIS Heer.

Phyll. Crét. du Nébr., p. 17, Pl. IV, Fig. 11; Lesquereux, Cret. Fl., p. 86, Pl. XXVIII, Fig. 12.

PROTEOIDES LANCIFOLIUS Heer.

Pl. XV, Fig. 5; Pl. L, Fig. 8.

Kreideflora v. Quedlinburg, p. 12, Pl. III, Figs. 5, 6; Lesquereux, Cret. and Tert. Fl., p. 50.

Leaves narrowly lanceolate, narrowed toward the apex and base, quite entire, blunt at apex. In Cret. and Tert. Fl. two specimens are described of this species. One of the specimens figured here (Pl. XV, Fig. 5) is No. 63 of the Museum of Comparative Zoology of Cambridge, Massachusetts; the other, No. 76, is also in that museum.

There is nothing to add to Heer's description. The figure of the species also fully agrees with those of Heer, differing only by the total absence of secondaries, none of which can be seen upon our specimen. The leaf is coriaceous, narrowed at base and also gradually toward the apex, which is apparently blunt or somewhat obtuse, but is broken in the specimen.

It has the same facies, being widest at the middle, curved-falciform, gradually narrowed to the base, 7^{cm} long, and 7^{mm} broad at the middle.

Habitat: Near Fort Harker, Kansas; Fig. 8, Pl. L, is No. 2778 (collector's No. 260) of the U. S. National Museum.

Order LAURINEÆ.

Tribe LITSEACEÆ.

LAURUS PLUTONIA Heer.

Pl. XIII, Figs. 5, 6; Pl. XXII, Fig. 5.

Fl. Foss. Arct., vol. 6, 2 Abth., p. 75; Pl. XIX, Figs. 1d, 2–4; Pl. XX, Figs. 3a, 4–6; Pl. XXIV, Fig. 6b; Pl. XXVIII, Figs. 10, 11; Pl. XLII, Fig. 4b.

Leaves subcoriaceous, lanceolate, narrowed both ways in the same degree, acuminate, entire; primary nerve rather narrow; secondaries numerous, at an acute angle of divergence, arcuate, the intervals reticulate.

This is Heer's description with which the Kansas specimens agree as well as with the figures of that author (loc. cit.). Many leaves of the same character have been seen in the specimens examined; but though they are of the same form and size, the reticulation is rarely distinct. Even the two leaves figured here are less distinctly reticulate than seen in the drawing. In Heer's figures also the reticulation is marked only upon one leaf (loc. cit., Fig. 6 of Pl. XX), and even there it is still obscure, appearing in small, polygonal areoles. Hence the identification of fragments of leaves of this species is not always certain. The lateral nerves are generally more or less undulate, especially in their upper part, not as distinctly curved near the borders as in *L. primigenia* Ung., of which the leaves are much alike and from which they differ by the narrow median nerve, the less thick texture, the surface not polished, and the basilar pair of secondaries at a more acute angle of divergence.

The leaf, Pl. XXII, Fig. 5, is doubtfully referred to this species. The nervation is totally obsolete, as it is also in most of the figures of the author, none of which has the upper part preserved. The form of the leaves is identical.

Habitat: Kansas, Minnesota, etc. No. 4093, in many specimens of the collection of Mr. R. D. Lacoe. Fig. 6 is from a specimen communicated by Prof. N. H. Winchell, from Minnesota, and figured on Pl. II, Fig. 5, of his Geological Report, as yet unpublished.

LAURUS NEBRASCENSIS Lesq.

Cret. Fl., p. 74, Pl. X, Fig. 1; Pl., XXVIII, Fig. 14.
***Persea nebrascensis* Lesq., Trans. Am. Phil. Soc., vol. 13, 1869, p. 431, Pl. XXIII, Figs. 9, 10.**

LAURUS PROTEÆFOLIA Lesq.

Cret. and Tert. Fl., p. 52, Pl. III, Figs. 9, 10; Pl. XVI, Fig. 6. Hayden's Ann. Rept., 1874, p. 342, Pl. V, Figs. 1, 2.

LAURUS HOLLÆ Heer.
Pl. XII, Fig. 8.

Fl. Foss. Arct., vol. 6, 2 Abth. p. 76, Pl. XXXIII, Fig. 13; Pl. XLIV, Fig. 5b; Pl. XLV, Fig, 3; vol. 7, p. 30, Pl. LXI, Fig. 3.

Leaves coriaceous, broadly lanceolate, entire; primary nerve narrow; secondaries distant, at an acute angle of divergence, arcuate.

The leaf, which is about 12^{cm} long, is nearly 4^{cm} broad in the middle, and narrowed in an outside curve to the base, declining to a short petiole 13^{mm} long. Of the leaves of this species Heer remarks that they are much like those of *L. plutonia* and *L. Odini*, but differ from the first by being broader, with secondaries more distant, and that in *L. Odini* the leaves are broadest below the middle. The difference in the width of the leaves of *L. Hollæ* and *L. plutonia* is still more marked in the American specimens in comparing the Kansas leaf with those of Pl. XIII, Figs. 5 and 6. The secondaries are a little more distinctly marked on the leaf from Kansas than upon those from Greenland. They are indeed very distant, but separated by very thin tertiaries, which are either totally obsolete or only perceivable near the point of attachment to the median nerve, the angle of divergence from the midrib being about 40°. The affinity of the Kansas leaf with that of *L. cretacea* Ett. (Kreideflora von Niederschoena, Pl. II, Fig. 13) is distinct. This has the nervation better preserved than any of those of *L. Hollæ*, showing strong, distant secondaries separated by thinner ones. The only appreciable difference is in the width of the leaves.

Habitat: Ellsworth County, Kansas. No. 865 of the collection of the museum of the University of Kansas. Collected by E. P. West.

LAURUS ANTECEDENS, sp. nov.
Pl. XI, Fig. 3.

Leaf membranaceous, lanceolate, gradually tapering to the apex, narrowed to the base, not decurrent, somewhat curved to one side, entire, irregularly undulate; median nerve thick; secondaries oblique, curved, parallel, but of unequal thickness and distance, camptodrome.

The leaf is 11^{cm} long, 2.5^{cm} broad below the middle, slightly inequilateral by the partial contraction of the borders on one side, and is not gradually narrowed to the petiole but somewhat rounded in narrowing to it. Its precise relation is not satisfactorily ascertained.

It is, indeed, comparable by its form to some varieties of *L. primigenia* Ung., and especially to *L. Reussii* Ett. (Flora v. Bilin, pt. 2, p. 5, Pl. XXXI, Figs. 5 and 11), having also, by its numerous intermediate tertiaries, a marked relation to species of Salix and even to *Dewalquea haldemiana* Sap. & Mar. (Marnes Heers. de Gelinden, Pl. VII, Figs. 1, 2). I consider it, however, as referable to a species of Laurus, comprising in its characters those of some varieties of *L. primigenia* Ung., resembling especially the figure of this species in Saporta, Études, vol. 2, Pl. VII, Fig. 7.

Habitat: Kansas. No. 4200 of the collection of Mr. R. D. Lacoe.

LAURUS ANGUSTA Heer

Pl. XVI, Fig. 7.

Fl. Foss. Arct., vol. 6, 2 Abth., p. 76, Pl. XX, Figs. 1b, 7; Pl. XLIII, Fig. 1c; vol. 7, p. 30, Pl. LVII, Fig. 1b.

Leaves linear-lanceolate, tapering to the acuminate apex, entire; primary nerves narrow, secondaries arcuate, camptodrome.

Heer remarks on the leaves of this species that they are much like those of *L. plutonia*, differing by the smaller size, the nearly linear form, being narrower and more acute at the apex. The fragment which I refer to this species is of exactly the same size and form as that in Heer's Pl. XLIII, Fig. 1c. It is indeed part of a leaf quite as large as those which I have figured of *L. plutonia*, Pl. XIII, Figs. 5, 6. But it is more linear, the secondaries are arched along the borders and are parallel, not flexuous, more distinctly camptodrome. Other leaves figured by Heer are much smaller, and some have the nervation better preserved, with the areolation like that of *L. plutonia*.

Habitat: Ellsworth County, Kansas. No. 709 of the museum of the University of Kansas; E. P. West, collector.

LAURUS (CARPITES) MICROCARPA, sp. nov.

Pl. XVI, Fig. 8.

Seeds small, oblong, obtuse, attached to a short pedicel, narrowed at base, enlarged above into a flat support of the seed, marked like it by five points of corresponding vascular scars.

This fruit is only half as large as that of *L. macrocarpa*, but it has the undoubted characters of a seed of the *Laurineæ*, like those of Laurus, Cinnamomum, Sassafras, etc. Its upper part, 5^{mm} long and 3.5^{mm} broad, rounded at apex, is supported upon a short pedicel 2^{mm} long, which, enlarged at its top, forms a support to the base of the fruit and is marked like it by corresponding vascular scars. The seed is easily separated from the embedding matter and also from its support.

It is comparable to the seeds of *Cinnamomum polymorphum* (Al. Braun) Heer (Engelhardt in Nova Acta, vol. 43, Pl. XIII, Fig. 11; Pl. XVII, Figs. 7–11).

Habitat: Ellsworth County, Kansas. No. 530 of the museum of the University of Kansas. Collected by E. P. West.

LAURUS TELIFORMIS, sp. nov.

Pl. L, Fig. 9.

Leaf small, rigid, subcoriaceous, lanceolate-acuminate, decurring to a thick, curved petiole, entire; midrib narrow, rigid; secondaries thin, very distinct, camptodrome, incumbent, quite near the border; the lowest pair basilar, distant from the upper one at a more acute angle of divergence; the upper gradually less distant and more open; areolation very small, punctiform.

This fine leaf is of thick texture, 6.5^{cm} long, including the thick curved petiole, which is over 1.5^{cm} long. It is only 12^{mm} broad at the middle, whence it is rapidly narrowed to a sharply pointed apex and very gradually tapers to the petiole, decurring to it at the base. It has eight pairs of secondaries, the lowest diverging from the base of the midrib at an angle of 20°; those above gradually less distant from each other under an angle of divergence of 30°, the uppermost of 50°.

The secondaries are thin, but passing through or cutting the epidermis of the leaf; all simple, following the borders in festoons. The character of the nervation is that of various species of Laurus of the Tertiary, being especially like that of *L. dermatophyllon* Weber (Ettingshausen in Flora v. Bilin, pt. 2, p. 7, Pl. XXXI, Fig. 8), *L. superba* Sap. (Études, vol. 2, Pl. VII, Fig. 4), *L. resurgens* Sap. (ibid., Fig. 9), etc.

Habitat: Kansas.

LAURUS KNOWLTONI, sp. nov.

Pl. L, Fig. 4.

Leaf large, linear, lanceolate, thick, coriaceous, with smooth surface; midrib stout; secondaries irregular in distance, thick, diverging about 40°

from the midrib, curving in passing toward the borders, camptodrome, not connivent.

The fragment is 14^{cm} long, 3.5^{cm} broad at the middle, in the broadest part, equally but gradually narrowed upward and downward, joining the base of the thick midrib in decurring to it, apparently pointed at apex.

Though the leaf has some likeness to those of *Ficus Berthoudi*, it evidently differs, especially by the great thickness of the secondaries, none of them being basilar and all in irregular position; yet it is evidently referable to Laurus, and comparable especially to *L. nectandroides* Ett. (Flora v. Bilin, pt. 2, p. 6, Pl. XXXI, Figs. 6, 7), the leaves of which are only smaller.

Habitat: Near Fort Harker, Kansas. No. 2713 of the collection of the U. S. National Museum.

Laurus macrocarpa Lesq.

Cret. Fl., p. 74, Pl. x, Fig. 2; Am. Jour. Sci., vol. 46, 1868, p. 98.

Laurophyllum ellsworthianum Lesq.

Pl. XIII, Fig. 7.

***Quercus ellsworthiana ?* Lesq., Cret. Fl., p. 65, Pl. VI, Fig. 7; Cret. and Tert. Fl., p. 39.**

Leaves subcoriaceous, with surface polished, lanceolate-pointed, rounded and broadly cuneiform to the base; borders entire, undulate; median nerve thick, percurrent; secondaries oblique, camptodrome, simple or forking.

This leaf, which is preserved entire, is 10.5^{cm} long, 2.5^{cm} broad in the middle, and has the secondaries, 13 or 14 pairs, inequidistant though parallel, either straight or slightly curved, at an angle of divergence of 40° to 50°, forking at or above the middle. This character is peculiar and well marked upon a fragment of a leaf figured in my Cret. Fl. as *Q. ellsworthiana* Lesq. But the general facies of the leaf as seen from the specimen figured here is rather that of leaves of Laurineæ. Its true relation is therefore still uncertain.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4096 of the collection of Mr. R. D. Lacoe.

Lindera venusta, sp. nov.

Pl. XVI, Figs. 1, 2.

Leaves rather small, thin, membranous, palmately triplinerved from the base and trilobate from above the middle, rounded in narrowing to the obtusely cuneate base; borders entire; lobes short, erect, the median a little longer, all blunt or apiculate at apex, enlarged at the middle, narrowed to the obtuse, narrow sinuses; secondaries numerous, camptodrome.

The leaves resemble those of *Sassafras cretaceum* Newb. They are generally smaller, also more delicate in appearance and of thinner texture, 6^{cm} to 7^{cm} long, 4.5^{cm} broad in the middle and between the apices of the lobes, entire. The divergence of the lateral primaries from the median nerve is scarcely 30°. In all their characters, form, size, texture, and nervation, these leaves closely resemble those of *L. triloba* Blume, of Japan. The most marked difference is in the division of the primaries, which are basilar in the fossil leaves, while they are generally supra-basilar in those of *L. triloba*, the leaves of which also have the lobes acuminate; but their form as well as that of the nearly rounded sinuses is the same.

Habitat: Ellsworth County, Kansas. Found in numerous concretionary specimens, mostly of small leaves. Nos. 656 and 657 of the museum of the University of Kansas.

LINDERA MASONI, sp. nov.

Pl. XVIII, Figs. 9, 10.

Leaves narrowly cuneate to the decurrent base, enlarged, flabelliform above, palmately deeply trilobate; lobes entire, obovate, rounded and apiculate at the apex, separated by very narrow, obtuse sinuses, palmately trinerved from above the base; primary nerves rigid, though narrow; secondaries short, alternate, curved, camptodrome.

The leaves are rather membranous than coriaceous, though somewhat thick, 7^{cm} long, 5^{cm} to 6^{cm} between the points of the lateral lobes, narrowed by an inward curve and decurring to the petiole, which is slender and broken below the base of the leaf; the secondaries are short, mostly obsolete.

This leaf is very similar to those of the preceding species, differing by its larger size, the long narrowed and decurring base, the supra-basilar position of the lateral primaries and the scantiness of the scarcely distinct secondaries. The texture of the leaf appears also more dense.

Habitat: Four miles southwest of Brookville, Kansas. No. 4135 and counterpart of the collection of Mr. R. D. Lacoe.

LITSEA CRETACEA, sp. nov.

Pl. XV, Fig. 2.

Leaf coriaceous, entire, narrowly oblong-lanceolate, gradually tapering upward to a long acumen, more rapidly narrowed to the base and decurring to the petiole; triplinerved; lateral primary nerves supra basilar, emerging at an acute angle of divergence, ascending close and parallel to the borders and like the secondaries anastomosing in festoons and ascending high up along the borders; secondaries alternate, the lower one-sided from near the primaries, the upper in four pairs, very distant, all connected by strong nervilles at right angles to the median nerve.

The only leaf I have seen of this species is the one figured. It is 13^{cm} long, 3^{cm} broad below the middle, the base and apex being broken. The texture is thick, the median nerve strong, the lateral primaries and secondaries thin, and all of the same thickness.

Species comparable to *L. expansa* Sap. & Mar. (Révision Fl. de Gelinden, p. 68, Pl. XI, Figs. 1, 2), and to *L. elatinervis* Sap. & Mar. (ibid., p. 70, Pl. XI, Fig. 4), and also, but in less degree of likeness, to *L. laurinoides* Hosius and v. d. Marck (Fl. Westfäl. Kreidef., p. 65, Pl. XL, Fig. 157).

Habitat: Ten miles northeast of Delphos, Kansas. No. 4014 of the collection of Mr. R. D. Lacoe.

LITSEA FALCIFOLIA, sp. nov.

Pl. XI, Fig. 5.

Leaves small, entire, coriaceous, lanceolate-acuminate, curved to one side, granulose on the surface, triplinerved from above the base; median nerve thin, lateral primaries very oblique, ascending high, nearly parallel to the borders, simple and very thin; secondaries, two pairs, far distant from the primaries, all simple and parallel, the lower opposite, the upper one-sided.

This leaf resembles somewhat the one described as *Cinnamomum Scheuchzeri* Heer (Lesquereux, Cret. Fl., p. 83, Pl. XXX, Fig. 2), differing, however, greatly by its falcate form and its very thin, simple nerves, not only from the last species but from all those attributed to the genus Cinnamomum. The nervation has more analogy to that of the living *L. glauca* Siebold of Japan, though the affinity is not complete. But the leaves from the Dakota Group rarely show a perfect accordance of characters with those of the present time. It is especially the case with the Laurineæ, to which a number of leaves from the Dakota Group are referable, but whose generic relation remains as yet unsettled.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4205 of the collection of Mr. R. D. Lacoe.

DAPHNOPHYLLUM ANGUSTIFOLIUM, sp. nov.
Pl. XXXVI, Fig. 8.

Leaves coriaceous, entire, long and narrowly lanceolate, gradually tapering upward to a long, acuminate point, more rapidly downward to the thick median nerve; secondaries at an acute angle of divergence, close, parallel, equidistant, camptodrome.

The genus Daphnophyllum has been admitted by Heer for the description of some leaves with camptodrome secondaries distributed somewhat like those of species of Ficus and Laurus.

This leaf is referred to this genus on account of its great affinity in form, size, and punctulate surface to leaves of some species of Laurus, being especially similar to those of *L. primigenia* Ung., var. *cretacea* Lesq. (Pl. XIII, Fig. 4), and others of the Tertiary of Europe, while at the same time, by the closeness of the simple camptodrome secondaries, it has a degree of likeness to species of Ficus, as *F. multinervis* Heer, of the Tertiary of Europe, and *F. atavina* Heer, of the Cretaceous of Greenland. It is 12^{cm} long, 2.5^{cm} broad at the middle, long-acuminate, and tapering also to the base (broken above the point of union to the petiole); the secondaries, very numerous, 3^{mm} to 3.5^{mm} distant, diverge at angle of 30° and curve slightly in passing toward the borders, following them in successive simple bows. The surface is rugose or punctulate, irregularly marked by small dots like the impression of basilar points of hairs.

The leaf is comparable to that of *Ficus degener* Ung., as figured in Watelet (Pl. Foss. du Bassin de Paris, Pl. XLII, Figs. 3–5). Unger describes his species in Fl. von Sotzka, p. 165, Pl. XIII, Figs. 1–7, as having the leaves broadly lanceolate, obtuse, narrowed to a short, thick petiole, dentate, crenulate; primary nerve strong; secondaries indiscernible. As described by Watelet, the leaves are linear-lanceolate, entire; the secondaries close, numerous, camptodrome, and crossed at right angles by distant nervilles. One of the leaves is punctulate and the areolation, or rather the secondary nervation, is not distinct. Our leaf well agrees with this last description, but certainly not with that of Unger, though Watelet sees no difference between his leaves and those described by Unger.

Habitat: Ellsworth County, Kansas. No. 97 of the museum of the University of Kansas; A. Wellington, collector.

DAPHNOPHYLLUM DAKOTENSE, sp. nov.
Pl. LI, Figs. 1-4; Pl. LII, Fig. 1.

Leaves entire, subcoriaceous, lanceolate, broader at the middle, gradually tapering upward to a long acumen, more rapidly to the base or to a short petiole; nervation camptodrome; midrib narrow; lower secondaries opposite, very oblique, curved in passing toward the borders, which they follow in simple festoons.

The leaves, which are about 8^{cm} long, and nearly 2^{cm} broad at the middle, have only eight pairs of secondaries, distinctly marked upon all the specimens except one. The lowest are opposite, passing toward the borders at an angle of 30°. They have the same form and the same type of nervation as the leaves of *Daphne protogæa* Ett. (Flora von Bilin, pt. 2, p. 13, Pl. XXXIV, Figs. 1-3). The resemblance to this last figure is especially remarkable. No. 1153 is evidently the same species and has a similar kind of nervation. Nos. 1160 and 1176 are variable forms of the same species.

Habitat: Probably Ellsworth County, Kansas. Nos. 1222a and 1224a of the collection of Mr. R. D. Lacoe. Fig. 1, Pl. LI, is No. 2807; Fig. 2, Pl. LII, and Fig. 1, Pl. LXIV are No. 2808 of the collection of the National Museum.

SASSAFRAS SUBINTEGRIFOLIUM Lesq.
Pl. XIV, Fig 2.

Cret. Fl., p. 82, Pl. II, Fig. 5.

Leaf subcoriaceous, ovate, acute, narrowed to the petiole, short, obtusely lobed on one side, entire on the other, triplinerved from above the base and at a distance from the secondaries, which are in three or four pairs, alternate, parallel, camptodrome, at an acute angle of divergence; nervilles distinct, curved in the middle, at right angles to the midrib and the secondaries.

The leaf is 6.5^{cm} long, 3.5^{cm} broad, narrowed and slightly decurrent to a slender petiole. The median nerve is narrow but rigid, quite distinctly marked, as well as the secondaries. Comparing this leaf to the half lobate ones of *S. officinale* L., the similarity of characters is easily observed. The basil nerves are alternate; one of them, slightly stronger, emerges on one side, forming a lobe and thus craspedodrome, while on the other side all the nerves are camptodrome and the borders remain entire. With the modification of one of the primary nerves the nervation is of the same character as that of *S. cretaceum* Newb., var. *obtusum* Lesq., and var. *acutilobum* Lesq. (Cret. Fl., Pl. XIII, Fig. 1, and Pl. XIV, Fig. 2). The only difference between these fossil leaves of Sassafras and those of the living *S. officinale* is, that in the first the lower secondary nerves pass toward the sinuses and curve at a short distance below the borders while in *S. officinale* the nerves reach the borders and there diverge on both sides, forming an inflated margin at the base of the sinuses as in the leaves referred to Lindera (Pl. XVI, Figs. 1, 2). The specimen described above is far better characterized than that figured in Cret. Fl. (loc. cit).

Habitat: Ten miles northeast of Delphos, Kansas. No. 4020 of the collection of Mr. R. D. Lacoe.

SASSAFRAS ? PRIMORDIALE, sp. nov.

Pl. XVI, Fig. 10.

Leaves of thin texture, palmately trilobate, narrowed to the base and decurring to the petiole, lobes lanceolate, blunt-pointed, the lateral short, half open, the median comparatively very long.

The small leaf, about 4.5^{cm} long, 3^{cm} broad between the apices of the lateral lobes, whose divergence from the median nerve is 50°, looks like a dwarfed leaf of Sassafras by its borders narrowed, decurring to the base, and joining the petiole at a distance from the point of union of the secondaries. The latter are effaced in the lateral lobes; a few of them, observable in the median one, are thin, curved in passing towards the borders, camptodrome. The middle lobe is gradually narrowed upward, is at least three times as long as the lateral ones, and is separated from them by obtuse sinuses.

Though the leaf is fragmentary, it is apparently related to *S. acutilobum* Lesq. and *S. Mudgei* Lesq. (Cret. Fl., Pl. XIV, Figs. 3, 4, and especially Pl. XXX, Fig. 7). The relation is not very closely marked, there being a great difference not merely in the size but in the substance of the leaves.

Habitat: Ellsworth County, Kansas. No. 525 of the museum of the University of Kansas. Collected by E. P. West.

SASSAFRAS MUDGEI Lesq.

Cret. Fl., Pl. XIV, Figs. 3, 4; Pl. XXX, Fig. 7.

SASSAFRAS ACUTILOBUM Lesq.

Cret. Fl., p. 79, Pl. XIV, Figs. 1, 2; Cret. and Tert. Fl., p. 56, Pl. V, Figs. 1–5.

SASSAFRAS (ARALIOPSIS) DISSECTUM Lesq.[1]
Pl. XIV, Fig. 1.

Cret. and Tert. Fl., p. 57.

Leaves coriaceous, very large, flabelliform, palmately five-lobed, narrowed by an inward curve and decurring to the petiole; lobes obtuse, deeply undulate or obtusely dentate; primary nerves trifid, supra-basilar; the lateral forking near their base, the divisions branched on both sides; secondaries curving along the borders or entering the teeth; nervilles strong, at right angles to the nerves, continuous, more generally simple, areolation small, polygonal.

These leaves are very large, the one figured measuring 22^{cm} in length, without the petiole, which is 7^{cm} long and 20^{cm} to 24^{cm} between the apices of the lateral lobes. They have a great degree of affinity to those of *S. (Araliopsis) mirabile* Lesq., and also of *Platanus primæva* Lesq., differing from both, however, by the subdivision of the lateral nerves, the five-lobate form of the leaves, the obtuse teeth of the lobes, the nervation, etc. They are like an intermediate link between those two genera, being more closely related to Araliopsis than to Platanus, however.

Habitat: A number of leaves of the same character but somewhat variable in size have been obtained by Charles H. Sternberg, 3 and 7 miles south of Fort Harker, Kansas, at a locality remarkable for their abundance. No. 117, etc., of the Museum of Comparative Zoology of Cambridge, Massachusetts.

SASSAFRAS (ARALIOPSIS) CRETACEUM Newb., var. GROSSEDENTATUM Lesq. n. var.

Pl. LI, Fig. 5.

This leaf differs in nothing from the normal form except by its large size, with its borders deeply dentate. It is evident that the sharply acute teeth constitute a variety indicated already by the short teeth sometimes seen in the normal form of the species and can not be separated on that account.

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[1] Prof. Lesquereux wrote of this species shortly before his death, as follows: "*Sassafras (Araliopsis) dissectum* Lesq., is clearly like *Aspidiophyllum trilobatum* Lesq., but positively differs by the lateral lobes being entire, not lobate nor dentate, and the coarse (distinctly so) nervation and areolation in the part of the surface of the leaves, generally very large, is smooth; in Asphidiophyllum it is, per contra, rugose, by the deeply marked areolation."—F. H. K.

SASSAFRAS (ARALIOPSIS) PAPILLOSUM, sp. nov.

Pl. VI, Fig. 7.

Leaves large, palmately trilobate; lateral nerves diverging, somewhat arched downward; borders acutely dentate all around, teeth entered by the secondaries and their branches, sharply pointed, papillose at apex; primary nerves three, very thick; secondaries oblique, parallel, more or less branching.

The fragment figured is the only part known of this beautiful leaf, which measured at least 22^{cm} between the extremities of the lateral lobes and about 20^{cm} in length without the petiole. The teeth are not large, but all about equal, turned outside, separated by shallow, half-round sinuses, each bearing at the apex a round black pulverulent point like a small flattened fleshy knot. The primary and secondary nerves are very thick; the lateral lobes and the secondaries are at an angle of divergence of 40° to 45° and the areas are traversed by strong, flexuous nervilles, simple or forking and at right angles to the nerves.

Though the general aspect of the fragment is like that of a leaf of Platanus, it has a more evident relation to *S. (Araliopsis) mirabile* Lesq., from which it differs merely by the enlarged lateral lobes, the acutely dentate borders and the papillose teeth. Like the preceding species this has a marked degree of affinity to *Platanus primæva* Lesq., and its varieties.

Habitat: Ellsworth County, Kansas. No. 19 of the museum of the University of Kansas. Collected by A. Wellington.

SASSAFRAS (ARALIOPSIS) CRETACEUM Newb.

Later Ext. Fl., p. 14, Illustr. Cret. and Tert. Pl., Pl. VI, Figs. 1–4, fragment of leaves; Lesquereux, Cret. Fl., p. 80, Pl. XI, Figs. 1, 2; Pl. XII, Fig. 2.

SASSAFRAS (ARALIOPSIS) CRETACEUM Newb., var. OBTUSUM Lesq.

Cret. Fl., p. 80, Pl. XII, Fig. 3; Pl. XIII, Fig. 1.

SASSAFRAS (ARALIOPSIS) MIRABILE Lesq.

Cret. Fl., p. 80, Pl. XII, Fig. 1.
Platanus latiloba **Newb., Later Ext. Fl., p. 23, Illustr., Cret. and Tert. Pl., Pl. II, Fig. 4.**

SASSAFRAS (ARALIOPSIS) RECURVATUM Lesq.

Cret. and Tert. Fl., p. 57.
Platanus recurvata **Lesq., Cret. Fl., p. 71, Pl. X, Figs. 3-5.**

SASSAFRAS (ARALIOPSIS) PLATANOIDES Lesq.

Cret. and Tert. Fl., p. 58, Pl. VII, Fig. 1.

Tribe PERSEACEÆ.

PERSEA SCHIMPERI, sp. nov.
Pl. XVI, Fig. 5.

Leaves coriaceous, oval-oblong, narrowed and contracted above to a blunt-pointed apex, narrowed in the same degree, but in an outside curve and broadly cuneiform to the base; primary nerve thick; secondaries inequidistant, the lowest thin, close to the borders, following them in anastomosing with those above; the others thick, all at an acute angle of 30° camptodrome.

The leaf, of which the petiole is destroyed, is 12^{cm} long and 6^{cm} broad; the secondaries, of which there are seven pairs, are variable in distance, slightly curved in traversing the blade, following the borders at a distance, anastomosing by branchlets in areoles; the areolation is small punctiform.

The form of the leaf is comparable to that of *P. speciosa* Heer,[1] which is a leaf somewhat larger, with the secondaries less distant and less gradually curving along the borders. The character of nervation and areolation is that of *P. Braunii* Heer,[2] a type also recognized in the Lower Eocene flora of Gelinden in *P. palæomorpha* Sap. & Mar., and which of course it is not surprising to find already represented in the Cenomanian of this continent, where so many original types of more recent plants make their appearance.

Habitat: Ellsworth County, Kansas. No. 781 of the museum of the University of Kansas; E. P. West, collector.

PERSEA HAYANA, sp. nov.
Pl. XVI, Fig. 6.

Leaf large, coriaceous, oval, contracted below the pointed apex, gradually narrowed and decurring to the petiole; secondaries opposite, equidistant, parallel, anastomosing by nervilles into large, simple areoles.

The leaf is nearly of the same size and form as that of the preceding species, from which it evidently differs by the still thicker texture, the polished surface, the longer, prolonged base joining the petiole by a declining

[1] Ettingshausen in Foss. Fl., Bilin, pt. 2, p. 9, Pl. XXXII, Fig. 16.
[2] Fl. Tert. Helv., vol. 2, p. 80, Pl. LXXXIX, Figs. 9, 10.

curve, and by the equidistant, parallel, opposite secondaries, the lowest pair of which are supra-basilar. These differences are marked enough to authorize a separation of species.

By comparison with plants of our epoch the leaves of *P. Schimperi* Lesq. show affinity of character with those of *Laurus canariensis* Willd., var. *latifolia*, while the leaves of *P. Hayana* Lesq. are more like those of var. *angustifolia* Lesq. of the same species.

Habitat: Ellsworth County, Kansas. No. 858 of the museum of the University of Kansas. Collected by E. P. West.

PERSEA LECONTEANA Lesq.
Pl. XI, Fig. 2.

Cret. Fl., p. 75, Pl. XXVIII, Fig. 1.

Leaves large, oblong-ovate, lanceolate, pointed; borders entire; nervation pinnate; lower secondaries at a more acute angle of divergence, the others distant, curving quite near the borders and following them; nervilles thin.

The leaf figured in Cret. Fl. (loc. cit.) is more complete than this fragment; but this shows the nervation more distinctly, especially the more acute angle of divergence of the lower pair of secondaries. As the leaves of *P. Leconteana* Lesq. and of *Magnolia tenuifolia* Lesq. (Cret. Fl., p. 92, Pl. XXI, Fig. 1) have nearly the same form and the same size, the fragment here figured is valuable in showing the difference in the character of the nervation.

Habitat: Ellsworth County, Kansas. No. 68 of the museum of the University of Kansas; A. Wellington, collector.

PERSEA STERNBERGII Lesq.

Cret. Fl., p. 76, Pl. VII, Fig. 1.

CINNAMOMUM SCHEUCHZERI Heer.
Pl. XI, Fig. 4.

Fl. Tert. Helv., vol. 2, p. 85, Pl. XCI, Figs. 4–22; Lesquereux, Cret. Fl., p. 83, Pl. XXX, Figs. 2, 3.

Leaf coriaceous, entire, elliptical, blunt at apex, narrowed from the middle downward, triplinerved from near the base; median nerve thick; lateral primaries nearly parallel to the borders, branching outside; secondaries one or two pairs, at an open angle of divergence, short, at a great distance from the base of the lateral primaries.

Though the position of the lateral primary nerves at the base of the leaves seems different from what is observed in the common forms of this species, the same anomaly is nevertheless seen in many of the leaves described by authors, as in Unger's Flora of Radoboj, Pl. I, Figs. 6, 8, 9, etc.

These leaves have the same characters as those described in Cret. Fl. (loc. cit.), and the remark made there is also applicable to this leaf.

Habitat: Seven miles northeast of Glascoe, Kansas. No. 428a of the Museum of Comparative Zoology of Cambridge, Massachusetts.

CINNAMOMUM HEERI Lesq.
Pl. XV, Fig. 1.

Cret. Fl., p. 84, Pl. XXVIII, Fig. 11; Trans. Amer. Phil. Soc., vol. 13, p. 431, Pl. XXIII, Fig. 12; Cret. and Tert. Fl., p. 54.

Leaves thick, coriaceous, entire, ovate, taper pointed, rounded to a short petiole; lateral primary nerves supra-basilar, ascending in curving to above the middle of the leaves; ramose outside.

The description of this species and the remarks upon its characters in Cret. and Tert. Fl. (loc. cit.) are complete as far as the species is known at the present time. But the figure given herewith has to be substituted for that in the Cret. Fl., Pl. XXVIII, Fig. 11, which had been made from a specimen deformed by handwork.

Habitat: Two and one-half miles from Glascoe, Kansas. No. 523 of the Museum of Comparative Zoology, Cambridge, Massachusetts.

CINNAMOMUM ELLIPSOIDEUM Sap. & Mar.
Pl. LI, Figs. 8, 9.

This species is described as follows by the authors (Révision de la Flore Heersienne de Gelinden, p. 61, Pl. IX, Figs. 7-9). "Leaves petiolate, ovate-lanceolate, shortly obtusely attenuate, triplinerved; lateral nerves slightly supra-basilar, curved, with few outside branches and few secondaries emerging from the midrib at a distance from the primaries, anastomosing in the upper part with them; tertiary nerves transversely flexuous, passing to a slightly marked areolation."

Except for the character of the areolation, copied from the description of the above authors, the species is satisfactorily represented by two specimens now in the collection of the U. S. National Museum. The character most important to separate this species from some forms of *C. polymorphum* (Al. Br.) Heer and *C. Scheuchzeri* Heer, is the position of the primary lateral nerves, which are quite near the base of the leaf. I have already described two leaves of this kind in Cret. Fl., Pl. xxx, Figs. 2 and 3, the first being comparable to Fig. 8 of Saporta and Marion (loc. cit.), being still narrower, with primary lateral nerves at a greater distance from the base of the leaf, not less than 8^{mm} (3^{mm} in the leaf of the French authors), and still narrower, the widest part in this last leaf being 18^{mm} while it is 25^{mm} in the leaf figured in the Flora of Gelinden. The character of the two leaves figured here agrees well with those of the leaves (Figs. 7 and 9) of Saporta and Marion as well as that of the fragmentary leaf of the Cret. Fl., Pl. xxx, Fig. 3. Even in this one the primary lateral nerves are really basilar, and thus it is evident that, admitting the characters as specific, three of our leaves represent *C. ellipsoideum* Sap. & Mar.

Admitting the identity of the leaves from Kansas with those from France, or considering them all of the same species, the difference mentioned above has to be put aside, and thus my remark on the leaves of Cinnamomum referable to *C. Scheuchzeri* Heer remains valid at least for Fig. 2 of the Cret. Fl. Heer has recognized, in the Upper Cretaceous of Patoot, and described[1] *C. ellipsoideum* in a fragmentary leaf which he refers to the species from the basilar position of the lateral primaries. It has the same character as that of Fig. 8 of our plate.

Habitat: Near Fort Harker, Kansas. No. 2712 of the collection of the U. S. National Museum.

CINNAMOMUM MARIONI, sp. nov.

Pl. LI, Figs. 6, 7.

Leaves narrowly elliptical, sharply acute, rounded at base in narrowing to the petiole, entire, subcoriaceous; midrib narrow, lateral primaries two pairs, one from the base, ascending in following the borders to below the middle of the leaf, the other supra-basilar, joining the midrib about 1^{cm} above the lower, but parallel, curving at a distance from the borders, tending to the apex but effaced and disappearing at a short distance below.

By their texture, form, and nervation these two leaves are very much alike, are of simple nervation, and appear referable to Cinnamomum. Their texture, if not very thick, is solid and their surface smooth. I am, how-

[1] Fl. Foss. Arct., vol. 7, p. 31, Pl. LXI, Fig. 2.

ever, unable to find a published fossil species of the genus with two pairs of parallel simple lateral nerves at a distance from each other without trace of secondaries. Some living species of Cinnamomum have, however, the same character and present in the primary nervation of some of their leaves a distribution of the primary nerves like that of the leaves figured; *C. camphora* and *C. Zeylanicum*, for instance. These peculiar characters are a variation of the normal form.

Leaves of Thibaudia have parallel lateral nerves which ascend to the apex, but they are differently disposed.

Habitat: Near Fort Harker, Kansas. No. 2695 of the collection of the U. S. National Museum.

CINNAMOMUM SEZANNENSE Watelet.

Pl. XII, Figs. 6, 7.

Daphnogene sezannensis (Wat.) Sap. & Mar., Fl. de Sézanne, p. 369, Pl. VIII, Fig. 5 (fragment); Sap. & Mar., Vég. Marnes Heers. de Gelinden, p, 47, Pl. VI, Figs. 5, 6; *Cinnamomum sezannense* Sap. & Mar., Révis. Fl. Gelinden, p. 60, Pl. IX, Figs. 2–6. Heer, Fl. Foss. Arct., vol. 6, 2 Abth., p. 77, Pl. XIX, Fig. 8; Pl. XXXIII, Figs. 11, 12. vol. 7, p. 30, Pl. LXI, Fig. 1a.

Leaves subcoriaceous, narrowed to the petiole from an obtuse base, lanceolate above, acute or narrowed into a long acumen, entire, triple nerved; lateral nerves supra-basilar, ascending parallel to the borders, short branched on the outside, anastomosing above with the secondaries; nervilles numerous, flexuous, transversely decurrent.

The above description is that of Saporta (Révision of the Gelinden Flora, loc. cit.). It is somewhat modified from that in Flore de Sézanne and also from that in the first volume of the Flora of Gelinden. The leaves which represent the species are mostly in fragments. That in the Flora of Sézanne, like our Fig. 6, has the upper and lower parts destroyed. It is much narrower, apparently longer, the lateral secondaries being shorter, less parallel to the borders than in our Fig. 7. Both figures of the Flora of Gelinden are also fragmentary, fully agreeing in form, size, and nervation with Fig. 6 of our plate; those of the Révision are smaller, one only (Fig 6) being preserved entire. It is a small leaf with a prolonged acumen. The figures given by Heer (Fl. Foss. Arct., loc. cit.) are also all of fragmentary leaves, those of Pl. XXXIII, Fig. 11, and Pl. LXI, Fig. 1a, being of better preserved leaves, much narrower than those of the Dakota Group, with the lateral nerves straight, resembling altogether the figure in the Flora of Sézanne. From a comparison of all the forms represented it appears that both the leaves figured here are essentially broader than any of those figured by authors, but not differing in a marked degree from the characters described by Saporta. They merely represent a large form of the species.

Habitat: Ellsworth County, Kansas. Nos. 167 and 679 of the collection of the University of Kansas. Collected by A. Wellington and E. P. West.

OREODAPHNE CRETACEA Lesq.

Cret. Fl., p. 84, Pl. XXX, Fig. 5; Cret. and Tert. Fl., p. 55.

Order MONIMIACEÆ.

Tribe ATHEROSPERMEÆ.

LAURELIA PRIMÆVA, sp. nov.
Pl. XX, Fig. 8.

Leaf thick, coriaceous, with surface polished, rhomboidal, entire and cuneiform from the middle downward, undulately obtusely dentate above; penninerved; primary nerve thick; secondaries mixed, camptodrome or craspedodrome; intermediate tertiaries as long as the secondaries, diversely forking and anastomosing obliquely or at right angles by nervilles.

The leaf, which is beautifully preserved, is 7.5^{cm} long, 4.5^{cm} broad in its widest part below the middle, and has a peculiar mixed nervation somewhat difficult to describe. The secondaries, at an angle of divergence of 40°, are mostly craspedodrome; but the upper ones evidently curve in bows quite near the borders, where they anastomose with somewhat thinner tertiaries, which, like the secondaries, and intermediate to them, either join the borders or branch and anastomose in curves with the secondaries, which are moreover connected to them by short nervilles at right angles. The secondaries are only slightly thicker than the tertiaries and their branches. The borders are finely, deeply undulate or obtusely dentate up to the apex, entire from below the middle to the base; the petiole is broken.

The affinity of this leaf with the genus Laurelia is indicated in fossil plants by *L. rediviva* Ung. (Sylloge, pt. 3, p. 71, Pl. XXIV, Figs. 4–9), and by a number of living species. Six leaves of the genus are represented by self-impression in Ettingshausen's Neuholl., Char. der Eoc. Eu., Figs. 126, 131, 138–140, pp. 88–90. *L. aromatica* Poir. (*L. sempervirens* Tul.), of Chili, is in the form, size, and the thick texture of its leaves, as well as in the type of nervation, remarkably similar to the fossil species.

Habitat: Ellsworth County, Kansas. No. 57 of the museum of the University of Kansas; A. Wellington, collector.

Order ARISTOLOCHIEÆ.

ARISTOLOCHITES DENTATA Heer.

Phyll. Crét. du Nébr., p. 18, Pl. II, Figs. 1, 2; Lesquereux, Cret. Fl., p. 87. Pl. XXX, Fig. 6.

APOCYNOPHYLLUM SORDIDUM, sp. nov.

Pl. LXIV, Fig. 11.

Leaf subcoriaceous, lanceolate, equally narrowed upward, acuminately and downward to the enlarged median nerve, which is gradually thinner above and scarcely visible toward the apex; borders entire; secondaries oblique, camptodrome.

The surface of the leaf is mostly covered with iron or yellowish crust, and few of the secondaries are distinct; they are at an acute angle of divergence, camptodrome.

The leaf is comparable to those figured and described as *A. lanceolatum* Ung., and is described by Weber in his Tertiärfl. Niederrh. Braunkohlenform., p. 74, Pl. IV, Fig. 1.

Habitat: Ellsworth County, Kansas. No. 1187 of the collection of Mr. R. D. Lacoe.

Order EBENACEÆ.

DIOSPYROS PRIMÆVA Heer.

Pl. XX, Figs. 1–3.

Phyll. Crét. du Nébr., p. 19, Pl. I, Figs. 6, 7; Fl. Foss. Arct., vol. 6, 2 Abth., p. 80, Pl. XVIII, Fig. 1; vol. 7, p. 31, Pl. LXI, Fig. 5a, b, c; Newberry, Later Ext. Fl., p. 8, Illustr. Cret. and Tert. Pl., Pl. III, Fig. 8; Lesquereux, Cret. and Tert. Fl., p. 59.

Leaves of medium size, subcoriaceous, oblong, oval, entire, narrowed or rounded downward, and declined to the petiole at the very base. The median nerve is thick, secondaries parallel, equidistant, connected by strong nervilles at right angles, camptodrome, and following the borders in repeated bows.

These leaves clearly represent Heer's species, especially as figured in Phyll. Crét. du Nébr., Pl. I, Fig. 6. In the specimens figured in Fl. Foss.

Arct. (loc. cit.) the secondaries are sometimes separated by shorter, undulate tertiaries which are not observable in those of Kansas. The leaves are variable, according to age. Fig. 3 of our plate represents a very young one. The median nerve is strong and continues downward to a thick petiole more than 2^{cm} long, preserved in Fig. 2.

All the specimens figured and a number of others come from the same locality. The species is locally abundant in the Cenomanian of the United States, and Heer reports it from Greenland and also from Patoot, a somewhat higher stage of the Cretaceous, where it is found with *Platanus affinis* Lesq., *P. Newberryana* Heer, *Ilex borealis* Heer, *Laurus plutonia* Heer, etc.; all species also found in the Dakota Group.

Habitat: Ellsworth County, Kansas. Nos. 64, 65, and 72 of the museum of the University of Kansas. Collected by A. Wellington.

DIOSPYROS APICULATA, sp. nov.

Pl. XIV, Fig. 3.

Leaf small, coriaceous, entire, elliptical, narrowed in the same degree upward to an apiculate apex, downward to a short petiole; nervation thick and deep, camptodrome.

The leaf has the characters of *Diospyros primæva* Heer, as figured in Fl. Foss. Arct., vol. 7, Pl. LXI, Fig. 5, but differs especially in its smaller size, the apiculate point and the more distant, opposite secondaries. It is 3.5^{cm} long, including the short petiole, which is only 2^{mm} long, and is 17^{mm} broad in the middle.

The nervation is quite distinctly marked; the secondaries, of which there are six pairs, are subopposite, while even the smallest leaf of *D. primæva* has ten pairs of secondaries. The nervilles are strong, flexuous, divided in the middle, anastomosing at right angles and thus forming large square or polygonal areoles; the rigid median nerve is prolonged into a short, apiculate point.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4016 of the collection of Mr. R. D. Lacoe.

DIOSPYROS AMBIGUA Lesq.

Cret. and Tert. Fl., p. 60.
D. anceps Lesq., Cret. Fl., p. 89, Pl. VI, Fig. 6.

DIOSPYROS PSEUDOANCEPS Lesq.
Pl. XXII, Fig. 1.

Report of the Geological State Survey of Minnesota, by Prof. N. H. Winchell, unpublished.

Leaf coriaceous, elliptical-oval, obtusely cuneiform to the base; borders entire; median nerve strong; secondaries few, curved in traversing the lamina; nervilles irregular in direction, except as the branches of the secondaries, anastomosing in festoons along the borders.

The leaf, which is 4^{cm} broad, is apparently 7 to 8^{cm} long, the upper part being destroyed. Comparing it to *D. anceps* Heer (Fl. Tert. Helv., vol. 3, p. 12, Pl. CII, Fig. 17), the affinity of the characters is really striking. In the American specimen the base of the leaf is only slightly less rounded; the lateral nerves are as irregular in distance; those of the lower pair closely follow the borders in a continuous series of bows formed by anastomosis from a superior nerve to a marginal inferior veinlet or to upper secondaries; the thin nervilles, variable in distance, are either at right angles to the secondaries and obsolete or pass from the median nerve to join the secondaries at a distance or in irregular or abnormal direction. As the leaf is fragmentary the comparison of the characters of the nervation can not be followed in the upper part; but as in Heer's Fig. 17, one sees near the line of fracture of the leaf two pairs of opposite secondaries ascending and curving towards the borders under the same angle of divergence.

Habitat: North side of the Big Cottonwood River, near New Ulm, Minnesota. No. 5372 of the collection of Prof. N. H. Winchell, who allowed the reproduction of this fine species here. A specimen more recently communicated, Ellsworth County, Kansas (No. 776 of the museum of the University of Kansas; E. P. West, collector), shows still more distinctly its remarkable relation to *D. anceps.*

DIOSPYROS STEENSTRUPI ? Heer.
Pl XVI, Fig. 9.

Fl. Foss. Arct., vol. 7, p. 32, Pl. LXIV, Fig. 1.

Leaves elliptical-ovate, acute or constricted below the apex and acuminate, attenuated to the base, entire; secondaries curved in traversing the blade, branching, camptodrome and areolate along the borders.

The species is represented by two fragmentary leaves upon the same specimen. The leaves are about of the same size and form as those figured by Heer (loc. cit.) from Patoot. The secondaries are either distant as in Fl.

Foss. Arct. (loc. cit.) Fig. 1a, or less distant, more divided, and more strongly impressed as in Fig. 1b of the same plate. They are, however, figured thinner and more flexuous in Heer's species than in the leaves from Kansas, of which the lower part is broken, but which are evidently narrowed and cuneiform to the base. They are also comparable to Göppert's *Rhamnus subsinuatus* (Palaeontogr., vol. 2, 1852, Pl. VI, Fig. 1d), at least by the form and nervation of the leaves; the borders, however, being entire, not sinuous, and the secondaries more divided.

Habitat: Kansas. Nos. P and Q of the museum of the University of Kansas.

DIOSPYROS ROTUNDIFOLIA Lesq.
Pl. XVII, Figs. 8–11.

Cret. Fl., p. 89, Pl. xxx, Fig. 1.

Leaves of various size, subcoriaceous, entire, round or broadly oval, obtuse, declining at the base to the petiole; nervation camptodrome.

The leaves of this species, recently found in great numbers, are extremely variable in size, from 1.5^{cm} to 7^{cm} long, and from 1^{cm} to 7^{cm} broad in the middle. Some of the leaves are as broad as they are long; but the greatest number are oval and much longer than broad.

The primary nerves are rigid; the secondaries, six to seven pairs, oblique, at a broad angle of divergence of 50° to 60°, arched in traversing the blade and simply areolate along the borders by anastomosing curves, mostly simple or branching near the borders. Though the surface of the leaves is quite smooth and the nerves very distinct, the ultimate areolation is not discernible; in these specimens the areas only are seen traversed by thin, simple nervilles, slightly oblique to the secondaries. The details of areolation have been observed and figured upon the fragment in Cret. Fl. (loc. cit.) Fig. 1, which appears to be referable to the same species, though the leaf is a little larger and quite round.

Besides the affinities of these leaves as indicated in the Cret. Fl., they can also be compared to species of Populus, especially to *P. hyperborea* and *P. Stygia* Heer, described above; also to the living *Coccoloba punctata*, of which a leaf is represented by impression in Ettingshausen's Bilin Flora, pt. 1, Pl. XXIV, Fig. 1; and *Coccoloba floridana* Meisner, the leaves of which, like those of the Dakota Group, are very variable in form and size.

Habitat: Kansas. Abundantly found in nodules of Ellsworth County. Nos. 402, 436, 570, 572, etc., of the museum of the University of Kansas. Collected by E. P. West.

DIOSPYROS ? CELASTROIDES, sp. nov.

Pl. XX, Fig. 7.

Leaves large, subcoriaceous, oblong-lanceolate, narrowed to a thick, short, inflated petiole and decurring to it at the base; borders quite entire; median nerve thick; secondaries numerous, oblique, thin, flexuous, with short, oblique branches on the under side, forking near the borders; nervation dictyodrome.

The fragment figured, which consists of the lower half of a leaf 7^{cm} long and 4^{cm} broad below the middle, is somewhat inequilateral, being 2^{cm} on one side and 1.5^{cm} on the other, thus resembling by its outline *Sapindus Morrisoni* Lesq. (Cret. and Tert. Fl., Pl. XVI, Figs. 1, 2), whose nervation is of a far different type. The secondaries, at an angle of divergence of 40°, are thin in comparison to the thick median nerve, flexuous, emitting on the lower side short oblique branches, without connection between themselves or with upper or lower secondaries, but entering the borders by some of their ultimate divisions.

The same type of nervation is exhibited by some species of Celastrinæ, as *Celastrophyllum belgicum* Sap. & Mar.,[1] *C. Benedeni* Sap. & Mar.,[2] two species with dentate leaves; but also and more distinctly by *Dospyros palæogæa* Ett.,[3] a leaf larger than that from Kansas but of the same form, and *D. primæva* Heer, as figured in Fl. Foss. Arct., vol. 6, 2 Abth., Pl. XVIII, Fig. 11. The petiole, as seen in Fig. 7, is short, 1.5^{cm} long, inflated at the base.

Habitat: Ellsworth County, Kansas. No. 83 of the collection of the museum of the University of Kansas; A. Wellington, collector.

Order SAPOTACEÆ.

Tribe BUMELIEÆ.

BUMELIA ? RHOMBOIDEA, sp. nov.

Pl. LI, Fig. 10.

Leaf rhomboidal in outline, entire, narrowed from the middle downward to a short petiole, upward in the same degree to an obtuse apex; nervation pinnate; secondaries oblique, camptodrome.

The leaf is small, 4^{cm} long, and 2^{cm} broad in the middle; the secondaries obscure, of three pairs only, opposite, parallel, equidistant, observed

[1] Flore de Gelinden, Révis., Pl. XIII, Fig. 4. [2] Ibid., Pl. XIV, Fig. 2.

[3] Flora v. Bilin, pt.2, p. 45, Pl. XXXVIII, Fig. 32.

in the lower part of the leaf. They are scarcely 5^{mm} distant and run straight toward the borders at an angle of divergence of 45° from the midrib.

By form and size, and also by the secondary nervation, as far as can be observed, this leaf is comparable to *B. Oreadum* Ung., as figured in O. Weber, Tertiärfl. Niederrh. Braunkohlenform., Pl. IV, Fig. 4b.

Habitat: Kansas.

SAPOTACITES, sp.?

Pl. LXV, Fig. 3.

Fragment of a membranous oval or elliptical leaf, round emarginate at apex, gradually narrowed toward the base (destroyed); midrib narrow; secondaries curved in passing toward the borders, at a very acute angle of divergence, parallel.

The exact form of the leaf is not ascertainable; the areolation also is obscure; the divergence of the secondaries, of which there are four to five pairs, is only 25° to 30°.

Habitat: Ellsworth County, Kansas. No. 1189 of the collection of Mr. R. D. Lacoe.

Order MYRSINEÆ.

Tribe EUMYRSINEÆ.

MYRSINE CRASSA, sp. nov.

Pl. LII, Figs. 2, 3.

Leaves coriaceous, thickish, lanceolate, rounded in narrowing to the base, entire, penninerved; midrib narrow; secondaries thin, numerous, oblique, parallel, or curved and branching in or above the middle, mixed, camptodrome; areolation very compact, irregular.

The areolation of these leaves, though copied as exactly as possible, is not distinct. It is comparable to that of some species of Myrsine, as *M. melanophlea* R. Br.[1] or *M. Urvillei* DC.,[2] and to *M. borealis* Heer,[3] which represents a leaf much smaller, with an areolation less compact than that of the leaves from Kansas. A number of fragments are figured by Heer (loc. cit.), but all are smaller and more different in appearance from those from Kansas. One is 9^{cm} long, 3.5^{cm} to 4^{cm} broad at the middle; the other,

[1] Ettingshausen, Blatt-Skelete der Dikotyledonen, p. 85, Fig. 51.
[2] Ett., ibid., p. 84, Pl. XXXI, Fig. 4.
[3] Fl. Foss. Arct., vol. 6, 2 Abth., p. 81, Pl. XXIV, Fig. 7b.

which is narrowly lanceolate, is 5^{cm} long, 1^{cm} broad, and has the secondaries a little more oblique, and altogether the nervation is less distinct and more mixed. Though closely allied, the leaves from Kansas differ in form as well as in size, as they are evidently ovate-lanceolate. The smaller of the leaves has the secondaries less distant, while those of Fig. 3 have them less regular and modified by ramification at the middle. The angle of divergence of the secondaries is about the same.

Habitat: Near Fort Harker, Kansas. No. 2777 of the U. S. National Museum collection.

MYRSINITES ? GAUDINI Lesq.
Pl. LII, Fig. 4.

Leat subcoriaceous, with polished surface, entire, oblanceolate or obovate-elongated, gradually enlarged from the base upward, obtuse, short petioled; midrib narrow; secondaries oblique, curved, camptodrome, and incumbent along the borders.

A small leaf, 5.5^{cm} long, 2.5^{cm} broad in the upper part; it has eight pairs of secondaries at an angle of divergence of 40°. The leaf is comparable to *Myrsine grandis* Ung.,[1] by the form of the leaf and the character of the nervation. The midrib, however, is narrower in the leaf from Kansas, which has the petiole destroyed.

Habitat: Kansas.

Order ERICACEÆ.

Tribe ANDROMEDEÆ,

ANDROMEDA PARLATORII Heer.
Pl. XIX, Fig. 1; Pl. LII, Fig. 6.

Phyll. Crét. du Nébr., p. 18, Pl. I, Fig. 5; Fl. Foss. Arct., vol. 3, No. 2, p. 112, Pl. XXXII, Figs. 1, 2; vol. 6, 2 Abth., p. 79, Pl. XXI, Figs. 1b, 11; Pl. XLII, Fig. 4c; Lesquereux, Cret. Fl., p. 88, Pl. XXIII, Figs. 6, 7; Pl. XXVIII, Fig. 15.

The leaf shown in Fig. 1 is larger than any of those figured by Heer; but it has the same characters as those represented in Fl. Foss. Arct., vol. 3, Pl. XXXII, Figs. 1, 2. It is introduced here on account of the superposition upon its base of an undeterminable small fragment of a leaf, apparently referable to Myrica.

[1] Flora von Kumi, Pl. XI, Fig. 37.

The other leaf of *A. Parlatorii* Heer has the same character as that figured in Cret. Fl., Pl. XXIII, Fig. 7, a peculiar form which Heer recognized as referable to this species which is really very variable. It differs from the more common form by the more obtuse apex and the large size of the leaf at the middle.

Habitat: Kansas. Common.

ANDROMEDA PARLATORII Heer, var. LONGIFOLIA, n. var.

Pl. LXIV, Fig. 19.

May be a different species. The leaves are much longer, 10^{cm} to 14^{cm} long, 2^{cm} to 3^{cm} broad, lanceolate, long acuminate. The texture is thick, coriaceous; the nervation the same as in the normal form of *A. Parlatorii*, as I have figured it in my Cret. Fl. (loc. cit.). There are numerous specimens, some of them of the normal size.

Habitat: Ellsworth County, Kansas. No. 662 of the collection of Mr R. D. Lacoe.

ANDROMEDA TENUINERVIS, sp. nov.[1]

Pl. XXXVIII, Fig. 7.

It has the short, enlarged petiole of *A. Parlatorii*, but the secondaries are very thin, scarcely visible, parallel, equidistant, immersed in the thick parenchyma; leaf thick, coriaceous, covered with a parasite, probably a new species of Placidium.

Habitat: Ellsworth County, Kansas. No. 1177 of the collection of Mr. R. D. Lacoe.

ANDROMEDA PFAFFIANA Heer.

Pl. XVIII, Figs. 7, 8; Pl. LII, Fig. 7.

Heer, Fl. Foss. Arct., vol. 6, 2 Abth., p. 79, Pl. XXV, Fig. 6; Pl. XXXVIII, Figs. 5–7; Pl. XLIV, Fig. 12.

Leaves membranous or subcoriaceous, linear-lanceolate, gradually narrowed to the petiole, tapering upward to a long acumen, entire; median nerve narrow, little enlarged near the base; secondaries very thin, partly obsolete, more or less distant, parallel and generally opposite, curved up towards the borders and turned down in reaching the median nerve.

The leaves appear very long, at least in comparison to their width, none of them being entire. The best preserved one is 14.5^{cm} long and 2^{cm}

[1] This species was first referred to *A. Parlatorii*, but was later regarded as a new species.—F. H. K.

broad at the middle; the lateral nerves join the median nerve at an acute angle of 20° to 25°.

The identification of the two leaves figured here with Heer's species is conclusive, although none of the figures given by Heer are complete, all representing leaves broken at the middle. The nervation, form, and size of the leaves as given by Heer (loc. cit., Pl. XXXVIII, Fig. 5), is exactly similar to that of our leaves. Heer describes the leaves as linear, but their facies could not be judged from the fragments which he had for examination.

This is the finest and best preserved specimen of *A. Pfaffiana* Heer which I have seen as yet. It has all the characters of the species as described.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4201 and 4202 of the collection of Mr. R. D. Lacoe.

ANDROMEDA SNOWII, sp. nov.
Pl. XVII, Fig. 16.

Leaves small, coriaceous, entire, regularly lanceolate, broader at the middle, tapering upward at the acute apex and in the same degree downward to the base; primary nerve stout; secondaries parallel, equidistant, oblique, 45° of divergence, camptodrome.

The leaf, which is 4.5^{cm} long and 1.5^{cm} broad at the middle, is allied in form to *A. protogæa* Ung., a species commonly represented in the Miocene of Europe; but it is still more intimately related to *A affinis* Lesq.,[1] a species also known by a single leaf, which differs by its punctulate areolation, and the narrower, longer, acuminate form. In *A. Snowii* the secondaries, though thicker from the middle of the base, as in *A. affinis*, ascend higher, curve in more distinct bows, forming by anastomosis a double series of festooning areoles. The apex of the leaf is not acuminate, but rather blunt-pointed, and the lower pair of secondaries are close to the borders and follow them at a more acute angle of divergence than that of the others above it.

Habitat: Ellsworth County, Kansas. No. 495 of the museum of the University of Kansas. Collected by E. P. West.

ANDROMEDA CRETACEA, sp. nov.
Pl. XVII, Figs. 17, 18; Pl. XXIV, Fig. 5.

Leaf small, membranous, narrowly lanceolate, acuminate, tapering to the base, entire; median nerve straight; secondaries, nearly equidistant

[1] Cret. and Tert. Fl., p. 60, Pl. II, Fig. 5.

and parallel, much curved in coming near the borders, which they follow in simple arches; intervals reticulate by thin nervilles.

The specimens are mere fragments of leaves with the apex destroyed. The form of the leaves and the nervation refer them evidently to some species of Ericaceæ, being especially in close relation to *A. vaccinifolia* Ung.,[1] for the size and form of the leaf (Fig. 5), and to *A. protogæa* Ung., as figured (loc. cit., Pl. CI, Fig. 26d). The affinity to this last species, even by the form of the leaf, is really very close, the difference being merely in the less enlarged middle part of the Cretaceous leaves. In Figs. 17 and 18 of our Plate XVII the leaves are smaller, the secondaries are more distant, at a more acute angle of divergence, and form longer bows nearer to the borders. The fragments may represent a different species. But still more striking variations in the angle of divergence of the secondaries, their distance and their relative position along the border are often to be observed in leaves of the same species of Andromeda.

Habitat: Ellsworth County, Kansas. Nos. 548a and 689 of the museum of the University of Kansas; E. P. West, collector. No. 4060, from ten miles northeast of Delphos, Kansas, is of the collection of Mr. R. D. Lacoe.

ANDROMEDA AFFINIS Lesq.
Pl. XXXVIII, Fig. 11.

Cret. and Tert. Fl., p. 60, Pl. II, Fig. 5.

A leaf more fragmentary than that in Cret. and Tert. Fl. (loc. cit.), but with the same characters.

ANDROMEDA LINIFOLIA, sp. nov.
Pl. LII, Fig. 5.

Leaf small, coriaceous, rigid, equally and gradually narrowed upward to a long acumen, and decurring downward to a short, slender petiole; midrib narrow; secondaries obsolete, oblique, opposite or alternate, somewhat curved and camptodrome.

The leaf is slender, 6^{cm} long, broken near the apex, scarcely 1^{cm} broad below the middle, gradually narrowed upward and downward, apparently rigid and solid; surface polished; secondaries parallel.

None of the fossil species of this genus have leaves so rigid, so slender, and so gradually and equally tapering both ways, or so exactly lanceolate-acuminate. In its general form and size the leaf is comparable to that of

[1] Heer in Fl. Tert. Helv., vol. 3, p. 7, Pl. CI, Fig. 25.

Heer,[1] described as *A. revoluta* Al. Braun, differing especially by the gradually narrowing prolongation upward to a long acumen, and downward to a thin or very narrow, distinct petiole. It is also comparable to *A. subprotogæa* Sap. (Études, vol. 1, p. 227, Pl. VIII, Fig. 9).

Habitat: Ellsworth County, Kansas. No. 1210 of the museum of the University of Kansas. Collected by E. P. West.

ANDROMEDA WARDIANA, sp. nov.
Pl. LXIV, Fig. 17.

Leaf of thin texture, narrowly elliptical, blunt at apex, narrowed at the base to a short petiole, and entire; median nerve narrow; secondaries thin, oblique, camptodrome.

This species is similar in the form and size of the leaves to *A. vaccinifolia* Ung., as figured by Heer in his Fl. Tert. Helv., vol. 3, Pl. CI, Fig. 25a. The secondaries are only at a more acute angle of divergence in the American species. The leaf is 4.5^{cm} long, 17^{mm} broad at the middle, the petiole 7^{mm} long, and the angle of divergence of the secondaries nearly 40°.

Habitat: Ellsworth County, Kansas. No. 304 of the collection of Mr. R. D. Lacoe.

Order CAPRIFOLIACEÆ.

Tribe SAMBUCEÆ

VIBURNUM INÆQUILATERALE, sp. nov.
Pl. XXI, Figs. 2, 3.

Leaves large, subcoriaceous, enlarged and rounded upward from below the middle and dentate, more or less rapidly narrowed to the broadly cuneate, entire base, irregularly three to five palmately nerved from a little above the basal border; primary and secondary nerves oblique, nearly equidistant, the lower much branching outside, all craspedodrome.

The leaves are enlarged in the middle and vary in size from 6^{cm} to 8^{cm} broad, being about 1^{cm} broader than long. The divisions or teeth of the borders correspond to those of the nerves, each of these entering one of the teeth, which are short, at right angles to the borders, separated by shallow sinuses of the same type as those often remarked upon the leaves of the Dakota Group in species of Grewiopsis, Platanus, Betulites, Aralia,

[1] Fl. Tert. Helv. III, Pl. CI, Fig. 24.

etc. The primary nerves, two or three, rather alternate than opposite, are mostly equidistant with the secondaries and with the same angle of divergence (30° to 40°), much branching outside, the few lower branches only not corresponding to teeth, being camptodrome.

The species has a degree of affinity to *V. Schmidtianum* Heer[1], from which it differs by the leaves being cuneiform, not rounded at the base, the nervation subpalmately trifid, with lateral nerves somewhat more distant. The areolation and the form of the leaves are the same.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4192 of the collection of Mr. R. D. Lacoe.

VIBURNUM GREWIOPSIDEUM, sp. nov.

Pl. XXI, Fig. 4.

Similar to the preceding species; a single leaf, differing by smaller size, thinner texture and equilateral form. The secondaries are less distant, more branched, the nervilles connivent at an angle near the borders, with branches passing at right angles from the angular point of union to the borders as in leaves of Grewiopsis. The teeth are shorter, less marked, separated by flat sinuses. This and the preceding species are typical of *V. lantanoides* and *V. ellipticum* of our present flora.

Habitat: Ellsworth County, Kansas. No. 834 of the museum of the University of Kansas; E. P. West, collector.

VIBURNUM ROBUSTUM, sp. nov.

Pl. XX, Figs. 4–6.

Leaves coriaceous, polished on the surface, entire, oblong, oval or ovate, narrowed downward, slightly decurrent at the very base to a long, thick petiole, penninerved; median nerve thick, secondaries strong, camptodrome to brachydrome.

These fine leaves, which are 8^{cm} to 10^{cm} long and 5^{cm} to 6^{cm} broad at the middle, with a thick petiole 2.5^{cm} to 3^{cm} long, have a nervation comparable to that of the leaves of *Populus mutabilis* Heer, which they also resemble by their thick texture. The secondaries, diverging at an angle of 30° to 50° from the median nerve, fork at a distance from the borders, their divisions anastomosing in curves forming a double row of marginal areoles. This type of nervation is still very marked in some living species of Viburnum, as in *V. nudum* L., *V. Lentago* L., and its numerous varieties, and

[1] Flora of Sachalin, Fl. Foss. Arct., vol. 5, pt. 3, p. 43, Pl. XI, Figs. 4–8.

in some fossil species, such as *V. Strangei* Mass[1]., whose leaves are also coriaceous, strongly nerved but of diverse form; also in *V. rugosum* Pers. (*pliocenicum*) Sap. & Mar.[2]

The long, thick petiole of these Cretaceous leaves does not contradict their reference to Viburnum, for *V. lantanoides* Mx. has leaves with a very thick petiole, sometimes as long as 4^{cm}, and *V. nudum* L., which shows the same type of nervation and has leaves with petioles 2^{cm} to 2.5^{cm} long; and these, winged as they are, would appear, if they were seen compressed in the fossil state, still thicker than those figured here.

Habitat: Ellsworth County, Kansas. Nos. 12, 58, and 59 of the museum of the University of Kansas; A. Wellington, collector.

VIBURNUM ELLSWORTHIANUM, sp. nov.

Pl. XXI, Fig. 6.

A single incomplete leaf, resembling in form, size, and texture the specimen (Fig. 4) of the preceding species. It differs from it by a stronger nervation, the secondaries at unequal distance, simply camptodrome, curving quite near the borders, less ramose, the nervilles close, nearly at right angles along the median nerve.

Though far different in appearance, the leaf may be a variety of *V. robustum*.

Habitat: Ellsworth County, Kansas. No. 4 of the museum of the University of Kansas. Collected by A. Wellington.

VIBURNUM LESQUEREUXII,[3] sp. nov.

Very variable in a diversity of characters which it is almost impossible to characterize or consider as specific.

Leaves round or broadly ovate, obtuse, pointed or longer, lanceolate above, round, cordate, subtruncate or slightly narrowed and cuneate at the

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[1] Massalongo-Scarabelli, Fl. Foss. Senigall., p. 280, Pls. X, XI, Fig. 4.

[2] Recherches sur les Végét. Foss. de Meximieux, in Arch. du Mus. d'Hist. Nat. de Lyon, vol. 1, p. 262, Pl. XXXI, Figs. 1-3.

[3] This in Prof. Lesquereux's manuscript is called "*Viburnum dakotense*, sp. nov.," but that name is preoccupied by the plant more appropriately so named by himself from the Bad Lands of Dakota in his Cretaceous and Tertiary Flora, p. 231, Pl. XLVI A, Fig. 9. While it seems a pity to disturb the name given by himself to so important a species, it is, under the circumstances, a necessity. It should not, however, be regarded as an unmixed evil, since it affords an opportunity to add one more honor to a name which is appended to very few species, considering the great number created by him who bore it.—L. F. W.

base, more or less distinctly and acutely dentate, penninerved. Midrib thick; secondaries, six to ten pairs, according to the size of the leaf, oblique, parallel, equidistant, straight in passing to the borders, the lower pairs ramose, with sometimes underneath a thin basilar simple or marginal pair of nerves close to the borders.

As I have done for the leaves described as Betulites, I refer most of these to one species, with some variation indicated by an additional name.

All the leaves have the areas traversed by distinct, simple nervilles, more or less curved at the middle, about at right angles to the secondaries; the nervilles become often nearest to the borders, angularly plicate in the middle and there joined to a vertical branch tending to the borders. The petiole of these leaves is strong, straight, nearly 5^{cm} to 6^{cm} long, inflated and curved at the base as in Betulites; the dentation of the borders is varied, the teeth being sometimes sharp and distinct, sometimes scarcely marked.

The leaves considered as essential varieties are figured as follows:

VIBURNUM LESQUEREUXII var. COMMUNE, n. var.

Pl. LIII, Fig. 2.

This is the form the more generally observed. Leaves small, truncate or subcordate at base; basilar nervilles very thin, quite near the borders, and simple; teeth of the borders distinct.

VIBURNUM LESQUEREUXII var. ROTUNDIFOLIUM, n. var.

Pl. LII, Fig. 8.

Leaves nearly round; teeth regular, small, base broadly cuneiform; secondaries oblique; marginal none.

VIBURNUM LESQUEREUXII var. CORDIFOLIUM, n. var.

Pl. LII, Fig. 9.

Leaves larger, more or less deeply cordiform at base, obtusely pointed at apex, distinctly dentate; lowest secondaries nearly at right angles, none simple and marginal.

VIBURNUM LESQUEREUXII var. LONGIFOLIUM, n. var.

Pl. LIII, Fig. 1.

Leaves large, cordate at base, long, tapering upwards to the obtusely pointed apex; lower secondaries arched backward in passing to the borders, the basilar submarginal. It is an enlarged form of var. 3, with very fine, large leaves.

No. 2701 of the U. S. National Museum collection, from near Fort Harker, Kansas.

VIBURNUM LESQUEREUXII var. LATIUS, n. var.
Pl. LII, Fig. 10.

Leaves enlarged, both sides obtuse at apex; coarsely dentate; lower secondaries open with a pair of thin basilar veinlets underneath.

It is apparently a small leaf of the same variety, only differing by the absence of marginal nerves.

VIBURNUM LESQUEREUXII var. LANCEOLATUM, n. var.
Pl. LIII, Fig. 3.

Leaves round, cuneiform at base, of small size, lanceolate pointed, lower secondaries, of which there are two pairs, nearly at right angles, simple, marginal; the borders distinctly dentate.

No. 2701½ of the U. S. National Museum collection.

VIBURNUM? LESQUEREUXII var. TENUIFOLIUM, n. var.
Pl. LXIV, Fig. 13.

Uncertainly referred to Viburnum. From the other forms of *V. Lesquereuxii* the leaf differs by its thin texture, its oblong-ovate shape, the thin, less deeply marked nervation and the nearly entire borders, the teeth being very small, like those of *Betulites Westii*, var. *subintegrifolius* Lesq. In general characters it is remarkably similar to the figure of *Corylopsis multiflora*, given by Saporta in the text to his Flora of Sézanne (p. 394). It differs by its broad diameter, the more open secondaries, and the direction of the small border teeth. I rather think the leaf referable to the Hamamelideæ.

Habitat: Ellsworth County, Kansas. No. 1186 of the collection of Mr. R. D. Lacoe.

VIBURNUM SPHENOPHYLLUM, sp. nov.[1]
Pl. LIII, Fig. 4.

Leaves long and narrowed, broadly cuneiform at base, tapering to the pointed apex; distinctly, equally dentate on the borders; longer and

[1] This species was named "*Viburnum cuneatum*, n. sp.," by Prof. Lesquereux, but this name is preoccupied by the *Viburnum cuneatum* of Newberry (Foss. Pl. from West N. A., Proc. U. S. Nat. Mus., vol. 5, p. 511). It was therefore necessary to change the name, and I have called it *Viburnum sphenophyllum*.—F. H. K.

comparatively narrower; secondaries parallel and all ramose; none simple and basilar; teeth sharply pointed, distinct, mostly equal; surface of the leaves smooth.

It is probably a variety of *V. Lesquereuxii*, but it has a peculiar aspect, being equally and distinctly dentate, with secondaries parallel, all ramose, the nervilles more distinct. All these forms and many others were found at the same localities; none, however, are identical or were found at the same place with the leaves described as Betulites.

VIBURNITES CRASSUS, sp. nov.[1]

Pl. XLV, Figs. 1, 2, 3, 4.

Leaves very thick, coriaceous, round in outline, subcordate or subtruncate and entire at base, denticulate above, triplinerved; nerves thick; lateral primaries open, branching outside with one, rarely two, pairs of lower basilar simple veinlets which are thin and at right angles; secondaries, four to five pairs, equidistant and parallel, craspedodrome with their divisions; angle of divergence 45° to 50°.

These leaves vary in size from 6^{cm} to 10^{cm} in both vertical and transverse directions. The borders are denticulate, more distinct, and with more distant teeth, but the kind of border division or dentation is of the same character, the small teeth being at right angles to the borders, as formed by the more or less strong projection of the nerves and of their branches, and separated by shallow sinuses. The texture of the leaves is thick and the areolation coarse and deeply marked, especially in Fig. 4, a fragment which may perhaps represent a different species, its areolation being evidently in smaller meshes than in the two other leaves. Fig. 3 has only one basilar veinlet on one side, while Fig. 4 has the lateral primaries emerging from the base of the lower secondaries and a pair of basilar veinlets. This difference, as well as the nearly entire borders of the leaf, renders its reference to this species somewhat uncertain.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4163, 4167, 4168 of the collection of Mr. R. D. Lacoe. No. 839, Fig. 4, of the museum of the University of Kansas. Collected by E. P. West.

[1] This species was first entered in the manuscript and described under the name of *Protophyllum crassum* by Prof. Lesquereux, but in pencil the name was changed to Phyllites. In a still later note he said: "Omit *Protophyllum crassum* of Pl. XLV, which is a Viburnites. *Protophyllum crassum true* is a new species described from Lacoe's specimen, No. 1171."

Protophyllum crassum "true" is figured from Lacoe's specimen, No. 1171, on Pl. LXXVII, Fig. 4, and also described from the manuscript description of the specimens furnished Mr. Lacoe by Prof. Lesquereux.—F. H. K.

VIBURNITES MASONI, sp. nov.

Pl. XLV, Fig. 5.

Leaves coriaceous, round, subcordate at the entire base, obtusely short-dentate, subtripalmately nerved; median nerve strong; primary lateral nerve supra-basilar, opposite and oblique like the secondaries, which are equidistant and parallel to it; basilar primaries two pairs at right angles, the upper branching on the lower side, anastomosing in bows with the lower one, quite thin and marginal; secondaries compound-craspedodrome, branching and anastomosing toward the borders in oblique subdivisions, and nervilles forming rows of angular meshes.

This leaf differs from Protophyllum by the characters of the areolation and the subdivisions of the secondaries toward the borders of the leaves, where they branch first obliquely, and by the anastomosis of branchlets in oblique and even rectangular directions ultimately enter the teeth by nervilles, as in species of Grewiopsis. The leaf is 9^{cm} broad and about 7.5^{cm} long, the petiole being broken near the base of the leaf.

Habitat: Ellsworth County, Kansas. No. 52 of the museum of the University of Kansas. Collected by A. Wellington.

Order CORNACEÆ.

CORNUS PRÆCOX, sp. nov.

Pl. XXIII, Fig. 5.

Leaves polished on the surface but not thick, elliptical, tapering upward to a long acumen; narrowed in an outward curve to the base and decurring to a short petiole, entire; median nerve rigid; secondaries inequidistant and parallel, at an acute angle of divergence, much curved in traversing the blade, simple or forking above the middle.

One leaf only of this kind has been found. It is 8^{cm} long, 3.5^{cm} broad at the middle, somewhat undulate, with seven pairs of secondaries at an angle of divergence of 40°, those of the three lower and of the upper pair opposite those of the middle alternate, either simple or forking in parallel branches, which with the same degree of curve pass towards the borders and follow them quite near in long bows.

This fine leaf, remarkable for the forking of the secondaries, has a distinct affinity with that described as *C. Buchii* Heer[1], being of the same form,

[1] Ettingshausen, Fl. Foss. v. Sagor, pt. 2, p. 22, Pl. XIV, Fig. 31.

though somewhat smaller, with the same peculiar divisions of the secondaries. It, however, differs from the leaves described by Heer under the same name,[1] as well as from those in Ettingshausen's Flora v. Bilin,[2] the secondaries of all these leaves being simple and less curved. It has a distinct affinity to *C. Forschammeri* Heer,[3] of Atane (Cenomanian), described also in this volume from specimens obtained at a higher stage of the Cretaceous.

Habitat: Ellsworth County, Kansas. No. 32 of the museum of the University of Kansas; A. Wellington, collector.

Cornus platyphylloides, sp. nov.

Pl. LXIV, Fig. 15.

Leaves small, thickish, subcoriaceous or membranous, oval, narrowly obtuse and narrowed to the base, entire; median nerve thick; secondaries seven pairs, very oblique, slightly curved in traversing the lamina, parallel, subopposite and subequidistant.

The leaf, which is 4^{cm} long and 2^{cm} broad, has the secondaries diverging from the midrib at an angle of 30° and somewhat curved in passing toward the borders, the upper pair acrodrome. The form, size, and mode of nervation of the leaf, as well as the texture, are so remarkably similar to the small leaf of *C. platyphylla* Sap.[4] that it might be considered as identical.

Habitat: Ellsworth County, Kansas. No. 594 of the collection of Mr. R. D. Lacoe.

Nyssa Snowiana, sp. nov.

Pl. LII, Fig. 11.

Leaves comparatively small, ovate, abruptly contracted to a short acumen, cuneate to the short, thick petiole and slightly decurring to it at the base, penninerved; midrib strong, percurrent, secondaries parallel, subequidistant, camptodrome, curving in traversing the blade, branching in the upper part, following quite near the borders in simple areoles.

The leaf, which is 5^{cm} long and 3^{cm} broad at the middle, is entire, and has a petiole 1^{cm} long; the secondaries, of which there are eight or nine on each side, are very distinctly curved in passing toward the borders, which they follow in single bows. It is similar in its facies and character to *N. europæa* Ung.,[5] being only smaller. A small fruit, striate lengthwise, No.

[1] Fl. Tert. Helv., vol. 3, p. 26, Pl. cv, Figs. 6–9.
[2] Pt. 3, p. 4, pl. xl, Fig. 32.
[3] Fl. Foss. Arct., vol. 6, 2 Abth., p. 85, Pl. xliv, Fig. 13.
[4] Fl. Foss. Sézanne, p. 391, Pl. xi, Fig. 9.
[5] Sylloge, pt. 3, p. 73, Pl. xxiii, Fig. 19.

1250 of the Snow collection, is comparable in size, form, etc., to *Nyssidium grœnlandicum* Heer (Fl. Foss. Arct., vol. 3, pt. 3, Pl. II, Fig. 18).

Habitat: Ellsworth County, Kansas. No. 935 of the collection of the University of Kansas; E. P. West, collector.

Order ARALIACEÆ.

Tribe HEDEREÆ.

HEDERA CRETACEA, sp. nov.

Pl. XVIII, Fig. 1.

Leaves subcoriaceous, broadly rhomboidal in outline, obtusely trilobate, subcordiform at base; borders undulate between the lobes, entire downward, nervation palmately five divided from the base; lower primary nerves simple, short and thin, the upper thick, passing up to the point of the lobes, branching on the lower side and forking; secondaries four pairs, opposite, short, equidistant, and parallel with the upper primaries.

The only leaf seen of this species is 7^{cm} long, 8.5^{cm} broad between the points of the lobes, which are short and obtuse. The lower secondaries are thick, forking at the apex and becoming effaced before reaching the borders, being, however, apparently camptodrome like the branches of the primaries.

The species has points of relation first with the living *H. Helix* L., by its form, being, however, less deeply cordiform at the base, and by its nervation, which is five-nerved from the base in the living species, which has also four pairs of opposite secondaries, all dividing before reaching the borders. Of fossil species this leaf is related to *H. Strozzii* Gaud.,[1] of the Miocene; to *H. auriculata* Heer,[2] with, however, a marked difference in some of the characters.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4029 of the collection of Mr. R. D. Lacoe.

HEDERA MICROPHYLLA, sp. nov.

Pl. XVIII, Figs. 2, 3.

Leaves broadly rhomboidal, obscurely trilobate, palmately trinerved from the base, obtuse and obtusely undulate-lobate above; secondaries two

[1] Gaudin et Strozzi, Contrib., pt. 1, Feuilles de la Toscane, p. 37, Pl. XII, Figs. 1–3.
[2] Fl. Foss. Alask., p. 36, Pl. IX, Fig. 6.

pairs, opposite and equidistant, craspedodrome, branches of the lateral primaries camptodrome.

The leaves on which the species is based have nearly the same characters as the large leaf (Fig. 1,) appearing really as a diminutive form of the same species. As seen by the figures, the difference in size is very great; but it is quite as marked between Figs. 3 and 2 as between this and Fig. 1. Essential differences are seen in the thickness of the lateral primary nerves and in the texture of the leaves, which is much thicker in Fig. 1 than in Figs 2 and 3, and in the emarginate apex of these two last-mentioned leaves. In spite of these differences the value of this last species may remain doubtful, for Figs. 2 and 3 closely imitate the nervation of Fig. 1, as both of these leaves have a thin lateral nerve on one side, while that of Fig. 1 has two, a difference caused by the reduced size of the leaves.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4026 (Fig. 2) and 4053a (Fig. 3) of the collection of Mr. R. D. Lacoe.

HEDERA PLATANOIDEA Lesq.

Cret. and Tert. Fl., p. 65, Pl. III, Figs. 5, 6; Hayden's Ann. Rept., 1874, p. 351, Pl. III, Fig. 3.

Leaves coriaceous, subreniform, broader than long, rounded or obtusely lobate at apex; abruptly narrowed or obliquely subtruncate at base; three nerved from a short distance above the base; lateral primaries curving, nearly parallel to the borders, anastomosing by thick branches and nervilles with marginal veinlets underneath; secondaries few, flexuous, irregularly branched, curving along the borders and anastomosing above, entering the teeth directly or by short veinlets, or slightly marked denticulations of the borders.

The reference of the fragments figured here to the species described in Cret. and Tert. Fl. (loc. cit.) is authorized by the identity of the nervation which, though extremely mixed and variable, is easily recognized.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4174 (Fig. 4) and 4021 (Fig. 5) of the collection of Mr. R. D. Lacoe.

HEDERA ORBICULATA (Heer) Lesq.
Pl. XVII, Figs. 12–14.

Chondrophyllum orbiculatum Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 115, Pl. XXXI, Fig. 3c. Reconstructed Pl. XXXII, Fig. 13.

Leaves coriaceous, nearly round or reniform, entire or subemarginate at apex; secondaries numerous, the three lower pairs nearly joined at their base, much branching, camptodrome; areolation in large, quadrangular or polygonal meshes formed by the irregular subdivision of the nervilles.

The leaves vary from 2.5^{cm} to 5^{cm} in length, being nearly as broad, sometimes even more enlarged horizontally and subemarginate at apex, as in Fig. 12. Heer had only fragments of these leaves for reconstruction and none of the fragments give a representation of the apex. One of our leaves (Fig. 14) appears constricted and lobed at apex. This, however, may be a mere casual deformation, though the borders of the sinuses are partly distinct. This last form is like a transition between this and the following species. The petiole is from 6^{mm} to 17^{mm} long and a little enlarged at the point of attachment. This species is closely related to *H. parvula* Ward and *H. minima* Ward (Types of the Laramie Flora, p. 57, Pl. XXVI, Figs. 4 and 5.)

Habitat: Ellsworth County, Kansas. Nos. 756, 783, and 816 of the museum of the University of Kansas; E. P. West, collector.

HEDERA OVALIS Lesq.
Pl. XVII, Fig. 15.

Cret. Fl., p. 91, Pl. XXV, Fig. 3; Pl. XXVI, Fig. 4.
Chondrophyllum Nordenskiöldi? Heer, Fl. Foss. Arct., vol. 3, pt. 2, p. 114, Pl. XXXII, Figs. 11, 12; Pl. XXX, Fig. 4b.

Leaves coriaceous, entire, oval, obtuse, narrowed to the petiole, penninerved; median nerve stout; secondaries alternate, irregular in distance, closer towards the base, much branched, camptodrome; areolation in large polygonal or quadrangular meshes.

This leaf has the same characters of nervation, also the same form and size, as that figured in Cret. Fl., Pl. XXV (loc. cit). As the details of nervation are extremely well preserved and distinct, it has been possible to represent it more exactly. It can not be positively asserted that the leaf is referable to Heer's *Chondrophyllum Nordenskiöldi* (loc. cit.), which is merely represented in fragments. The leaf reconstructed by Heer (loc. cit., Pl.

XXXII, Fig. 12) differs by its smaller size, the secondaries being less numerous, at a more acute angle of divergence with few branches, and a different general aspect. The reference, however, of all these leaves to Hedera is authorized by their affinity to species of the genus; in nervation, to *H. Helix* L., in the form of the leaves and characters of the secondary nervation and areolation to *H. cuneifolia* from Cuba, and especially to *H. Gaudichaudi* Gray, of the Spanish Islands.

Habitat: Ellsworth County, Kansas. No. 824 of the collection of the museum of the University of Kansas. Collected by E. P. West.

HEDERA DECURRENS, sp. nov.

Pl. XVIII, Fig. 6.

Leaves subcoriaceous, small, subcordate, oblong-ovate, obtuse, entire, declining at base and decurring along the short petiole; nervation trifid from the top of the petiole; lateral primaries much branching; the secondaries at a great distance above the primaries, consisting of three parallel pairs, arched and forking near the borders, subcraspedodrome, vanishing in reaching the borders.

The leaf is 33^{mm} long and as broad above the rounded base; the primary and secondary nerves at the same angle of divergence of 45°; the lower pair of secondaries three times as distant from the primaries as from the upper secondaries above, leaving between them a wide space of 17^{mm} without nerves, except a short, thin one, marked on one side only in the middle of the space.

The species is comparable to *H. platanoidea* Lesq. (Cret. and Tert. Fl., p. 65, Pl. II, Figs. 5, 6), and is still more closely related in form and nervation to *H. auriculata* Heer (Fl. Foss. Alask., p. 36, Pl. IX, Fig. 6), from which it differs especially by the absence of a basilar marginal nerve and in the nervation being less distinctly camptodrome. This leaf is also comparable to that of *Myrsine antiqua* Ung. (Syll., pt. 3, p. 20, Pl. VII, Fig. 7), the form of the leaf with the winged petiole being the same, but the nerves of our species are more curved and distinctly camptodrome.

The decurrent base of the petiole is not seen in any of the species above quoted.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4031 of the collection of Mr. R. D. Lacoe.

Tribe ARALIEÆ.

ARALIA FORMOSA Heer.

Fl. v. Moletein, p. 18, Pl. VIII, Fig. 3; Lesquereux, Cret. and Tert. Fl., p. 60, Pl. XI, Figs. 3, 4.

ARALIA SAPORTANEA Lesq.

Cret. and Tert. Fl., p. 61, Pl. VIII, Figs. 1, 2; Pl. IX, Figs. 1, 2. Hayden's Ann. Rept., 1874, p. 350, Pl. I, Figs. 2, 2a.

ARALIA SAPORTANEA Lesq., var. DEFORMATA, n. var.

Pl. XXIII, Figs. 1, 2.

Leaves small, palmately five lobate, lobes deformed, narrow, mostly entire.

In Fig. 1 the median nerve is partly abortive or reduced to half its length and width; while the lateral ones are nearly entire and equal. In Fig. 2 the lateral lobes are short, obtuse on one side of the leaf, longer and dentate on the other, and with secondaries obsolete. Comparing these leaves to those of the normal forms (loc. cit), one sees easily that the differences in the characters of these leaves is the result of casual deformation.

Habitat: Ellsworth County, Kansas. Museum of the University of Kansas.

ARALIA WELLINGTONIANA, sp. nov.

Pl. XXI, Fig. 1; Pl. XXII, Figs. 2, 3.

Leaves large, coriaceous, palmately three or five lobed, narrowed in an inward curve to a prolonged base, decurring to the petiole; lobes long, oblong-lanceolate, abruptly pointed, sharply equally dentate from above the base, the teeth turned outside or slightly upward, separated by shallow sinuses; primary nerves broad and flat; secondaries more or less oblique, slightly curving or nearly straight in passing to the borders, entering the teeth, craspedodrome, mostly simple; areolation distinctly reticulate, in irregularly quadrate or polygonal meshes.

The leaves, which are 15^{cm} to 16^{cm} long, excluding the petiole, vary of course in width according to the number of lobes and their divergence from the median nerve, which in most of the specimens that I have seen averages 35°. The lobes are a little broader in the middle, slightly narrowing to the sinuses, 7^{cm} to 10^{cm} long, and from 2^{cm} to 3^{cm} broad at the middle. The separate lobe (Pl. XXII, Fig. 5) has the teeth much larger, more turned upward, appearing also of a thicker texture.

The species is so remarkably similar to *A. Saportanea* Lesq.[1] that at first sight it appears identical. It differs, however, by the coriaceous texture of the leaves, the reticulate areolation, the larger teeth, the more or less upwardly turned secondaries, which are not curved or camptodrome, but run straight to the teeth and enter them; the base of the leaf is longer, decurrent, and the lobes more abruptly or obtusely pointed.

Habitat: Carneiro, Ellsworth County, Kansas. Nos. 14, 14a, b, c, of the museum of the University of Kansas. Collected by Mr. A. Wellington, to whom this fine species is dedicated.

ARALIA TOWNERI Lesq.

Pl. XXIII, Figs. 3, 4; Pl. XXXI, Fig. 1.

Hayden's Ann. Rept., 1874, p. 349, Pl. IV, Fig. 1; Cret. and Tert. Fl., p. 62, Pl. VI, Fig. 4.

As yet the species is known only by fragmentary specimens which do not sufficiently exhibit the essential characters. What is known of it and observed upon the fragments figured (one representing a small leaf, the other a large one, quite as large if not larger than that figured in Cret. and Tert. Fl., loc. cit.; the third, Pl. XXXI, of middle size) is that the leaves are subcoriaceous, polished on the surface, irregularly palmately five lobed from below the middle, narrowly cuneate to the base; the lobes entire, lanceolate obtuse; the primary lateral nerves forking at a distance above the base and the secondaries open, variable in distance, very much curved in passing toward the borders, camptodrome, with nervilles rarely distinct and at right angles to the nerves. The lateral primaries evidently join the median nerve as supra-basilar.

Fig. 3 represents a fragment of a small leaf, probably referable to this species. It seems to have a degree of relation to the Tertiary leaf, also fragmentary, of *A. Tschulymensis* Heer (Fl. Foss. Arct., vol. 5, pt. 2, p. 42, Pl. XIII, Fig. 1b).

Habitat: Ellsworth County, Kansas. No. 73 of the museum of the University of Kansas; A. Wellington, collector.

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[1] Cret. and Tert. Fl., p. 61, Pl. VIII, Figs. 1, 2; Pl. IX, Figs. 1, 2.

ARALIA MASONI, sp. nov.

Pl. XV, Fig. 4.

Leaf subcoriaceous, palmately 3 to 5 lobed; lobes oblong-lanceolate acute or acuminate, entire, long and narrow; primary nerve rigid, stout, percurrent; secondaries numerous, parallel, oblique, and curved.

The species is represented by a fragment, two lobes, finely preserved, showing part of an apparently palmately five-divided leaf. The lobes are 7^{cm} to 9^{cm} long, 2^{cm} broad in the middle or less, and are gradually narrowed from the middle downward to narrow obtuse sinuses and upward to the apex (broken), which is either acute or acuminate. The lateral nerves are close, 3^{mm} to 4^{mm} distant, oblique, at an angle of divergence of 50°, somewhat curved in passing toward the borders.

As far as can be seen from the fragment the species is closely related by nervation and also by length and width of the lobes to *A. angustiloba* Lesq.,[1] a species from the Upper Miocene of the auriferous gravels of California. By the shape of the lobes, their close disposition and narrow sinuses, the species is comparable to *A. Jorgenseni* Heer,[2] from Unartok, Greenland where it is associated with *Laurus primigenia* Ung., *Viburnum marginatum* Lesq., etc. Heer's species is represented by a trilobate leaf only, and the secondary nervation is totally obsolete. Hence, though the form, size, and relative position of the lobes are really the same as in the fragment figured here, it is not possible to identify the species.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4063 of the collection of Mr. R. D. Lacoe.

ARALIA SUBEMARGINATA Lesq.

Pl. XV, Fig. 3.

Cret. and Tert. Fl., p. 63.

Leaf large, coriaceous, palmately five-lobate; lobes short, rounded and emarginate at apex; primary nerves in three pairs, supra-basilar, the lateral ones forking at a short distance from their base; secondaries camptodrome, distant, much curved in passing toward the borders, which they follow more or less distantly, anastomosing in arches.

This fine leaf, which measures 17^{cm} horizontally and 9^{cm} vertically, is palmately five lobate, with the lateral primary nerves alternate at base,

[1] Mem. of the Museum of Comp. Zool., vol. 6, pt. 2, Pl. v, Figs. 4, 5.

[2] Fl. Foss. Arct., vol. 7, p. 116, Pl. ci, Fig. 1.

forking a little above it. The lobes are emarginate at apex, entire, short and separated by narrow, obtuse sinuses; the median nerve, which is continued from the petiole, is 3^{mm} thick, the lateral about half as strong. The secondaries are thick at base, much curved in passing to the borders and branch and anastomose near them, either with branches of those above or with long, continuous nervilles at right angles to the primaries; the areoles formed by subdivisions at right angles of the nervilles are nearly square, somewhat large.

This leaf is as yet without recognized affinity, except with the leaves described in my Cret. Fl., p. 56, Pl. II, Figs. 1–3; Pl. XXIV, Fig. 2; Pl. XXIX, Fig. 8, as *Liquidambar integrifolium;* and especially with the small fragment referred to *Sassafras cretaceum* Newb., var. *obtusifolium* Lesq. (loc. cit.), Pl. XXIX, Fig. 9. From these leaves, however, it differs greatly in the nervation, the primaries being supra-basilar and the secondaries distinctly camptodrome, as in certain species of Aralia.

Habitat: Three miles south-southeast of Fort Harker, Kansas. No. 810 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

ARALIA GRŒNLANDICA Heer.

Pl. LIV, Figs. 1–3.

Fl. Foss. Arct., vol. 6, 2 Abth., p. 84, Pl. XXXVIII, Fig. 3; Pl. XXXIX, Fig. 1; Pl. XLVI, Figs. 16, 17.

Leaves generally large, coriaceous, with smooth surface, five nerved from the top of the petiole, generally a little above the basil borders of the leaves, trilobate; base truncate and rounded, declining to the petiole; lobes equal, obtuse or apiculate, entire or sometimes short obtusely lobate; even broadly emarginate at apex, separated by half round, broad sinuses.

The leaves vary from 7^{cm} to 12^{cm} in diameter between the apices of the lateral lobes, and from 6^{cm} to 10^{cm} in length from the top of the petiole to the apex of the median lobe; the lateral nerves diverge from the top of the petiole, the lowest thinner, simple or ramose underneath, and curve along the entire borders or enter a short obtuse lobe; the upper ones are ramose on both sides, have their branches camptodrome, and are much curved in following the borders.

There is some difference in the characters of the leaves referable to this species as compared to those figured by Heer in Fl. Foss. Arct. (loc. cit.). The form, size, and texture are alike, but in Heer's figure the primary nerves are only three in Pl. XXXVIII, Fig. 3, the lateral supra-basilar, the lobes entire, while in Pl. XXXIX, Fig. 1, the nerves are five and the lobes narrower, the lateral trilobate along the base. This indicates a disposition of the leaves to become casually lobate. In Heer (loc. cit.), Pl. XXXIX, Fig. 3 is referred to *Platanus recurvata* Lesq. It is a trilobate leaf, five nerved, with the lobes entire, which really appears to be referable to *Aralia grœnlandica.*

Fig. 3 has some real analogy with my figure of *A. emarginata* of our Pl. XV, Fig. 4, which is referable as a variety perhaps of what I have formerly considered as *Liquidambar integrifolium.* It is, in fact, different, especially in the presence in this variety of two or even three pairs of basilar nerves parallel to each other. But there is, nevertheless, a distinct affinity showing it to be a continuation of the same type under a form somewhat different.

Habitat: Near Fort Harker, Kansas. Fig. 2, Pl. LXVI, is No. 2741 of the U. S. National Museum.

ARALIA BERBERIDIFOLIA, sp. nov.

Pl. XVI, Fig. 11.

A small coriaceous leaf or leaflet, palmately five-lobed from the middle; lobes oblong, rounded at apex to an abrupt sharply cuspidate point, separated by obtuse sinuses; primary nerves three, from above the base, lateral forking.

No traces of secondaries or areolation are observable upon the surface of this small leaf, which is only 2.5^{cm} long, 2^{cm} broad between the apices of the lateral lobes. The middle one is 15^{mm} long above the sinus, 5^{mm} broad, the lateral gradually smaller.

I do not know of any fossil species to which this one can be compared. Its five-palmate division refers it to the genus Aralia, however, of which many species are described from the Dakota Group. By its hard, coriaceous texture and the form of its sharply cuspidate lobes, it may be compared to species of Berberis, such as *B. trifoliolata* of Texas, whose leaflets, though generally trilobed, are sometimes five lobed and cuneate at the base. The genus Berberis is represented in the Miocene flora of Europe by five species, two of them of doubtful affinity, the others with linear leaflets without relation to this fossil leaf from Kansas.

Habitat: Ellsworth County, Kansas. No. 527 of the collection of the University of Kansas; E. P. West, collector.

ARALIA QUINQUEPARTITA Lesq.

Cret. Fl., p. 90, Pl. XV, Fig. 6.

ARALIA TENUINERVIS Lesq.

Cret. and Tert. Fl., p. 63, Pl. VII, Fig. 4.

ARALIA RADIATA Lesq.

Cret. and Tert. Fl., p. 64, Pl. VII, Figs. 2, 3.

ARALIA CONCRETA Lesq.

Hayden's Ann. Rept., 1874, p. 349, Pl. IV, Figs. 2, 3, 4; Cret. and Tert. Fl., p. 64, Pl. IX, Figs. 3–5.

Order MYRTACEÆ.

Tribe MYRTEÆ.

MYRTOPHYLLUM WARDERI, sp. nov.
Pl. LIII, Fig. 10.

A fragmentary leaf, subcoriaceous, with borders entire, gradually narrowing towards the base, there joining the base of the midrib, enlarged into a broad, short petiole or decurring to it; secondaries oblique, próximate, joined at apex to a marginal nerve following to the borders and undulate, separated by simple, parallel tertiaries.

Of this species there is only the fragment figured. It is part of a leaf enlarging gradually upward from a short, thick petiole; like a regular blade broken 8^{cm} from the base, where it is enlarged to 2^{cm}. The secondaries are oblique and straight, diverging 30° from the midrib, and are joined near the borders to a marginal nerve and generally separated by a single tertiary which is parallel, shorter and not connected with the marginal nerve. The nervation of the leaf is therefore comparable to that of some species of Eucalyptus of New Holland; *E. floribunda* Endl. and *E. acervula* Sieb. are both represented in Ettingshausen's Blattskelete der Dicotyledonen, p. 203. *Myrtophyllum pulchrum* Saporta (Monde des Plantes, p. 356, Fig. 113), has leaves much like those of this Cretaceous species. Saporta compares its leaves to those of *M. Geinitzi* Heer (Kreideflora von Moletein, p. 22, Pl. XI, Figs. 2, 3).

Habitat: Near Fort Harker, Kansas. No. 2754 of the U. S. National Museum.

EUGENIA PRIMÆVA, sp. nov.
Pl. LIII, Figs. 5–9.

Leaves small, coriaceous, elliptical-lanceolate, obtuse, gradually narrowed to short narrow petiole; midrib narrow; secondaries very oblique, thin, the lower pair opposite, a short distance above the base, ascending nearly parallel to the borders; those above alternate, more curved in passing toward the borders, simple, camptodrome.

The leaves are referable to this genus by all their characters and are comparable to those of *E. häringiana* Ung. (Fl. von Sotzka, p. 52, Pl. XXXV, Fig. 19). They vary from 4.5^{cm} to 8^{cm} in length, including a short petiole 6^{mm} to 8^{mm} long; the divergence of the secondaries is $20°$ to $30°$ from the midrib.

The leaf shown in Fig. 9 is larger, has a broader flat midrib, and the secondaries are more open. It may be a different species, though I provisionally named it var. *valida*. It is more closely related to *E. häringiana* Ung. as figured by Heer in Fl. Tert. Helv., vol. 3, Pl. CLIV, Fig. 13.

Habitat: Probably all near Fort Harker, Kansas. Figs. 6, 7, 8, are all numbered 2693 in the U. S. National Museum.

Tribe LEPTOSPERMEÆ.

EUCALYPTUS DAKOTENSIS, sp. nov.
Pl. XXXVII, Figs. 14–19.

Leaves coriaceous, linear, or gradually narrowed from an obtuse apex to the base, decurring into a short, alate petiole; borders recurved, median nerve strong; secondaries thin, oblique, proximate, parallel, camptodrome.

The species is represented by numerous fragments of very thick leaves, about 1^{cm} broad and at least 8^{cm} long; the borders are sometimes strongly recurved as in Fig. 15; sometimes flat as in Fig. 19, and judging from the fragment (Fig. 14) the leaves are obtuse at apex. The median nerve is thick, especially so on the lower surface, as in Fig. 19, where the flattened borders are seen decurring along the median nerve at base and thus bordering the short, margined petiole. The secondaries, which are 3^{mm} to 4^{mm} distant at the base, traverse the blade at an angle of divergence of $30°$ to $40°$, and, curving close to the borders, form by their crossing simple, incumbent bows, like a marginal nerve, distinctly seen only on the lower side of the leaves or of the fragments.

The species is intimately related to *E. Geinitzi* Heer, described below, the leaves of which are generally much larger. Heer considers his species as the equivalent of *Myrtophyllum* (*Eucalyptus*) *Geinitzi* of the Kreidefl. v. Moletein, p. 22, Pl. XI, Figs. 3, 4, represented by two leaves not any larger, 2.5^{cm} long, and tapering to an acumen, with the base not decurrent, but narrowed to a short, naked petiole. These material differences prevent the identification of the Kansas leaves with those of Moletein and Greenland, though the relation is very close.

E. dakotensis is also comparable to *E. angusta* Velenovský,[1] but differs by the base of the leaves decurring and apparently obtuse.

Habitat: Ellsworth County, Kansas. Nos. 53, 108, 674, 685, 710 of the museum of the University of Kansas; A. Wellington and E. P. West, collectors.

EUCALYPTUS GEINITZI Heer.
Pl. XXXVII, Fig. 20.

Fl. Foss. Arct., vol. 6, 2 Abth., p. 93, Pl. XIX, Fig. 1c; Pl. XLV, Figs. 4–9, fruits; Pl. XLVI, Figs. 12c, d, 13.

Leaves coriaceous, lanceolate or linear-lanceolate; narrowed to the apex and to the base; median nerve stout; secondaries at an acute angle of divergence, confluent with the marginal nerve.

There is only a fragment of a leaf, which, however, distinctly represents Heer's species, especially as figured on Pl. XIX, Fig. 1c, for the size of the leaves, the direction of the secondaries and their confluence with a marginal nerve, and on Pl. XLVI, Fig. 12c, for the areolation in large meshes formed by undulate nervilles cut at right angles by thin, intermediate tertiaries.

Habitat: Ellsworth County, Kansas. No. 775 of the museum of the University of Kansas; E. P. West, collector.

CALLISTEMOPHYLLUM HEERII Ett.
Pl. XXXVIII, Fig. 8.

Kreidefl. v. Niederschoena, p, 27, Pl. LII, Fig. 13.

Leaves small, coriaceous, entire, linear-lanceolate, acute at base, narrowed to the apex; primary nerve strong; secondaries very thin and close, at an acute angle of divergence.

The above is the description as given by Heer. The leaf from Kansas has exactly the same form as that from Niederschoena, being somewhat

[1] Flora der böhmischen Kreideformation, pt. 4, p. 3, Pl. III, Figs. 2–12.

twisted or inclined to one side, without trace of nervation, only slightly broader at the middle. I believe, therefore, that both these leaves represent the same species, though their true generic relation remains uncertain. The thickness, the form, and the size of these leaves seem to refer them to the Myrtaceæ. As no trace of the secondary nerves are marked upon the figure of the leaf by Ettingshausen (loc. cit.), it is probable that the nervation is described by the author of *C. melaleucæforme* Ett. of Häring, which he compares to his species.

Habitat: Ellsworth County, Kansas. No. 702 of the museum of the University of Kansas; E. P. West, collector.

Order HAMAMELIDEÆ.

HAMAMELITES TENUINERVIS Lesq.

Cret. and Tert. Fl., p. 70.

HAMAMELITES QUADRANGULARIS Lesq.

Hayden's Ann. Rept., 1874, p. 355; Cret. and Tert. Fl., p. 70.
***Alnites quadrangularis* Lesq., Cret. Fl., p. 62, Pl. IV, Fig. 1.**

HAMAMELITES KANSASEANUS Lesq.

Hayden's Ann. Rept., 1874, p. 355, Pl. VII, Fig. 4; Cret. and Tert. Fl., p. 70, Pl. IV, Fig. 5.
***Alnus Kansaseana* Lesq., Cret. Fl., p. 62, Pl. XXX, Fig. 8.**

A larger leaf than that figured under this name in the Cret. and Tert. Fl., Pl. IV, Fig. 5. The form of the leaf and characters of nervation are the same. But it is doubtful if these two leaves, though the base is rounded and connivent under the midrib, can be referred to the Hamamelideæ. Species of Quercus, such as *Q. latissima*, Hosius Paleontogr. vol, 17, Pl. XIII, Fig. 11, and *Q, westfalica* Hosius, & v. d. Marck, Westfäl. Kreideflora, Pl. XXIX, have some analogous characters.

HAMAMELITES QUERCIFOLIUS Lesq.

Cret. and Tert. Fl., p. 71.

HAMAMELITES? CORDATUS Lesq.

Cret. and Tert. Fl., p. 71, Pl. IV, Fig. 3.

PARROTIA? WINCHELLI, sp. nov.

Pl. XXIX, Figs. 5, 6.

Leaves coriaceous, of rough, undulate surface, rhomboidal, acute, broadly wedgeform at base, long-petioled, entire, penninerved or subtriplinerved; primary and secondary nerves thin, rigid, craspedodrome, simple or with few branches.

The leaves, of which there are two of the same form, vary from 7^{cm} to 8^{cm} in length, and from 5^{cm} to 6.5^{cm} in width, the petiole, which is preserved in the largest of them, measuring 5.5^{cm}, though still apparently broken at base. The secondaries, of which there are four to six pairs, are parallel, the lowest supra-basilar, equidistant, diverging from the median nerve at an angle of 40°, thin, straight in passing to the borders; the two lowest pairs only with a few branches; nervilles mostly simple, at right angles to the secondaries.

The relation of these leaves is not positively ascertained. The character of their nervation relates them to the genus Parrotia, by a degree of affinity with *P. pristina* Ett. (Flora v. Bilin pt. 2, Pl. XXXIX, Fig. 23 and pt. 3, p. 4, Pl. XL, Figs. 24, 25). But according to the description of the species by the German author the leaves are cordate-ovate, undulate, or sinuate, obtuse, truncate, emarginate at base, characters far different from those of the Kansas leaves.

Habitat: Minnesota; Ellsworth County, Kansas. No. 102 of the museum of the University of Kansas. Collected by A. Wellington.

PARROTIA GRANDIDENTATA, sp. nov.

Pl. XXXIX, Figs. 2–4.

Leaves subcoriaceous, not very thick, petioled, rhomboidal in outline, rounded in narrowing to the base and entire to the middle, subtruncate or narrowed to the apex; deeply, obtusely dentate-lobed above; median nerve strong; secondaries opposite, consisting of three to four pairs, curved in ascending upward and each entering one of the teeth, craspedodrome, simple, the lower supra-basilar; nervilles simple, somewhat flexuous, parallel, at right angles to the nerves.

The leaves are from 7^{cm} to 10^{cm} long and from 6.5^{cm} to 10^{cm} broad between the apices of the lateral lobes. They are ovate from the base to the middle, and there deeply dentate in narrowing to the apex; each of the secondaries, which are simple, parallel and arched in the same degree, entering one of the teeth. The nervilles, mostly obsolete, are seen especially at their point of union to the secondaries.

I do not find any other relation with these leaves than with the genus Parrotia. *P. pristina* Ett.,[1] has a marked degree of analogy with these leaves and with those of the preceding species. A distant affinity is also remarked with the leaves figured on Pl. XXXIV, Figs. 4, 7, 8, described as Acerites.

Habitat: Pipe Creek, Cloud County, Kansas. Nos. 4078c and 4081 of the collection of Mr. R. D. Lacoe.

PARROTIA CANFIELDI, sp. nov.[2]
Pl. XXX, Fig. 6.

Leaves coriaceous, entire, long-petioled, rhomboidal-ovate, palmately trinerved from near the base; primary and secondary nerves thick, craspedodrome; secondaries four pairs; nervilles deeply marked, simple or forking at the middle.

This is a beautiful leaf, preserved entire, 7.5^{cm} long, 6^{cm} broad in the middle, with a petiole nearly 2^{cm} long. The texture of the leaf is thick, its surface shining. Its apex is rather obtuse and slightly emarginate by the pressure of the excurrent strong midrib. The secondaries are nearly as strong as the primaries and pass like these straight to the borders, being mostly simple or without branches, the branches only of the lateral primaries being camptodrome.

The leaf is, in its aspect, like those of some species of Populus, a genus from which it differs evidently by the few secondaries, which are straight, parallel to the primaries, not curved at all in traversing the blade, not ramose and distinctly craspedodrome. It seems at first related essentially to Parrotia, being comparable to *P. pristina* Ett.,[3] the leaves of which are undulate-dentate and the nervation less distinctly palmately ternate. But its affinity is more marked with species of Hedera, like *Hedera platanoidea* Lesq.,[4] the leaves of which, also of coriaceous texture, merely differ by their truncate base, the supra-basilar disposition of the lateral primaries, the secondaries being thin and ramose.

Habitat: Kansas. No. 7 of the museum of the University of Kansas. Collected by Mr. S. N. Canfield, for whom it is named.

[1] Flora v. Bilin, pt. 3, p. 4, Pl. XXXIX, Fig. 23; Pl. XL, Figs. 24, 25.

[2] This species was first described under Hedera, but in a subsequent note was changed to Parrotia. The remarks on its affinities, which were made while it was retained under Hedera, are here reproduced in their original form.—F. H. K.

[3] Flora v. Bilin, pt. 3, p. 4, Pl. XXXIX, Fig. 23; Pl. XL, Figs. 24, 25.

[4] Cret. and Tert. Fl., p. 65, Pl. LII, Figs. 5, 6.

Order ROSACEÆ.

Tribe POMEÆ.

CRATÆGUS LAURENCIANA, sp. nov.
Pl. XXXVIII, Fig. 1.

Leaves large, obovate, rounded at apex, attenuate at base into a broadly margined petiole; simply dentate; primary nerve narrow; upper secondaries very oblique, ramose, the lower gradually more open, nearly at right angles, simple and curved up in the wing of the petiole.

A beautiful leaf of somewhat thin (not coriaceous) texture, 12.5^{cm} long including the long decurring base, 7^{cm} broad in the upper part. The middle secondaries, at an angle of 20° to 30° of divergence, are much branched outside in parallel, simple or ramose tertiaries; the lower are simple, gradually more open and less distant, becoming camptodrome in the wing of the petiole where they follow the borders in areoles. The teeth are blunt, short, simple, slightly turned upward and separated by shallow sinuses.

This species has, in the fossil plants, an intimate relation with *C. antiqua* Heer,[1] from which it differs in the borders, the nearly round upper part of the leaf, the broad, prolonged, decurrent base nerved in its whole length, the shorter, more distant teeth, etc. It may be compared also to *C. aria* L. var. *Perollana* Gaud.[2] Its nearest affinity is, however, with the leaves of some varieties of the living North American *C. tomentosa* L., which have a margined petiole, with the bordering lamina quite as large as in the Cretaceous species and nerved in its whole length.

Habitat: Ellsworth County, Kansas. No. 750 of the museum of the University of Kansas; E. P. West, collector.

CRATÆGUS TENUINERVIS, sp. nov.
Pl. LIV, Figs. 5–7.

Leaves oblong-ovate, dentate all around, once lobate at base, narrowed into a long petiole; midrib thin; lateral primaries slightly curved back, branching on both sides, prolonged to the apex of the lobes; secondaries simple or ramose, about equidistant, oblique, straight and parallel, ending in the large teeth.

This species is closely allied to the preceding, especially differing by its thinner texture, the dentate borders, and in being only one, lobed at base.

[1] Fl. Foss. Arct., vol. 1, p. 125, Pl. I, Figs. 1, 2.
[2] Gaudin et Strozzi, Contrib., pt. 4, p. 26, Pl. VII, Figs. 5, 6.

Fig. 5, which is a form of the same, is comparable to *Cratægus atavina* Heer,[1] of the Patoot Flora, which merely differs by the obtuse teeth. I have seen in the herbarium some young shoots of *C. spathulata* Michx., with their stipules, joined by their sides when dried and compressed; these stipules looked like a round appendage, superposed upon the base by oblanceolate leaves, passing above them and presenting, if not the same form (the leaves, being oblanceolate), at least an appearance of about the same character as this leaf.

Habitat: Near Fort Harker, Kansas. No. 2699 of the U. S. National Museum.

CRATÆGUS LACOEI, sp. nov.
Pl. LXIV, Fig. 14.

Leaves small, oval, apparently obtusely pointed, cuneate from below the middle to the base, with borders irregularly dentate above it; median nerve strong, secondaries at an acute angle of divergence, thick, parallel, mostly simple, craspedodrome.

There are two leaves of about the same size and form, 4.5^{cm} long, 3^{cm} broad at the middle, and of strong, rigid texture, but not coriaceous, with eight pairs of thick, straight, or rigid secondaries, which are mostly simple, reaching the borders and entering the irregular teeth, which are long pointed or short, slightly prominent, and diverging from the midrib at an angle of 25°. By their form, size, and character of nervation they are greatly like some of the leaves of *C. tomentosa*, being irregularly cut on the borders, with close, simple, parallel, and equidistant secondaries.

Habitat: Ellsworth County, Kansas. No. 572 of the collection of Mr. R. D. Lacoe, for whom the species is named.

CRATÆGUS ACEROIDES, sp. nov.
Pl. LIV, Fig. 8; Pl. LV, Fig. 1.

Leaves of medium size, coriaceous, ovate, simply or pinnately lobed; lobes entire; midrib narrow; secondaries mostly opposite, the lower pair slightly supra-basilar; open, curved back; those above parallel, more or less ramose, craspedodrome, their branches camptodrome.

There are only three fragmentary leaves of this species whose affinity with the preceding species is evident. They are somewhat like leaves of Acer, but their nervation is peculiar, the lower secondaries being parallel,

[1] Fl. Foss. Arct., vol. 7, p. 43, Pl. LXIV, Fig. 11.

arched downward, branching on both sides, and reaching the apices of short, obtuse, entire lobes.

As points of relation to the species I may quote *C. palæocantha* Sap.,[1] a very small leaf or fragment of a leaf, with the same characters of form and nervation, and especially some varieties of *C. oxyacantha* L., which, however, has generally the lowest pair of secondaries emerging at a greater distance above the base.

Habitat: Ellsworth County, Kansas. Nos. 1190 and 1191 of the collection of Mr. R. D. Lacoe.

PYRUS? CRETACEA Newb.

Later Ext. Fl., p. 12; Illustr. Cret. and Tert. Pl., Pl. II, Fig. 7.

Tribe PRUNEÆ.

PRUNUS CRETACEA Lesq.

Cret. Fl., p. 111, Pl. XXIII, Figs. 8, 9.

PRUNUS (AMYGDALUS)? ANTECEDENS, sp. nov.

Pl. LV, Fig. 4.

Leaves petioled, more or less broadly lanceolate, narrowed to the apex and to the base, entire; midrib of medium size; secondaries curved, oblique, camptodrome; nervilles and areolation obsolete; nut oblong, pointed at the upper end, truncate at base and there marked by a few strong, vertical striæ, flattened on one side along the border, rounded at the other.

All that is observable of this peculiar plant is distinctly shown upon the figure. One of the leaves is broader than the other but evidently belongs to the same plant; the secondaries are at an angle of divergence of 35° from the midrib, parallel, equidistant, slightly curved in passing toward the borders, effaced before reaching them, camptodrome. The fruit, which is convex on the surface and flattened on one side, is there bordered by a transversely striate band, truncate, rounded and marked by a few depressed lines at the other, and pointed at apex, and is a little more than 3^{cm} long, and 1.5^{cm} broad at the middle.

The fragment, comprising fruit and leaves as figured, seems referable to the section Amygdalus, of which a number of species have been published from the Tertiary. In the characters of the leaves, the size, form, and

[1] Études, vol. 1, pt. 2, p. 98, Pl. XI, Fig. 4.

nervation, it is very similar to *A. pereger* Ung., as figured in the Flora von Sotzka (p. 54, Pl. XXXIV, Figs. 10–16), or as it is figured in Ludwig's Foss. Pfl. Rhein.-Wett. Tertiär-Form. (p. 143, Pl. LIX, Figs. 3, 4), where the leaves are represented as entire. In this connection Schimper remarks that the leaves appear rather to be those of Sapindus, especially on account of their entire borders. The leaves of Prunus (Amygdalus) are as often entire as serrate. I find no reason to refer this fine species to any unknown genus.

Habitat: Kansas.

Order LEGUMINOSÆ.

Suborder CÆSALPINIEÆ.

Tribe AMHERSTIEÆ.

HYMENÆA DAKOTANA, sp. nov.

Pl. LV, Figs. 2, 3; Pl. LVI, Figs. 1, 2; Pl. LXII, Fig. 2.

Leaves compound, of two, very rarely three, elliptical or oblong lanceolate, entire leaflets, joined lower than the base of the pinnules and there obliquely parted; midrib narrow; secondaries oblique, parallel, curved in traversing the blade, camptodrome.

The species has numerous representatives, generally single detached leaflets, sometimes borne upon a short petiole, joined together, or very rarely three, at a distance of 1^{cm} to 2^{cm} below the basal borders and passing toward a stronger, common petiole. Three of the specimens, the best preserved ones, have been figured, as also a single one with three pairs of leaves. The pinnules vary greatly in size and the more or less acute base, some being more rounded in joining the petiole. The divergence of the secondaries, of which there are seven to eight pairs, is also slightly variable, being more or less open and variable in distance, even in the same leaves, generally diverging 40° to 50° from the midrib.

One leaf of this genus, *H. primigenia*, is figured by Saporta in his Monde des Plantes (p. 199, Fig. 2). The leaflets are joined nearer their base and thus less distant; the same species figured and described by Velenovský[1] has the leaflets still larger than those of the Dakota Group specimens, but with a shorter petiole, though longer than they are figured by Saporta, with secondaries less numerous and more distant. The difference may not be specific. The leaves figured by Velenovský are slightly crenate, while they

[1] Fl. böhm. Kreideform., pt. 3, Pl. V, Fig. 4; Pl. VI, Figs. 2–4.

are perfectly entire in our species. Saporta remarks that this genus of the Cæsalpinieæ is still represented in the flora of the Mediterranean by *Ceratonia siliqua* Caronbier, which forms large, open forests along the shore from Nice to Mentone. As yet no fructification has been found with these leaves in the Dakota Group, though the leaves are found in vast numbers in some localities; rarely, however, are the pinnules joined together.

Though the specimens represented by Figs. 1, 2, Pl. LXVIII, have the secondaries a little less distant, I consider them as of the same species.

Habitat: Kansas.

Tribe CASSIEÆ.

CASSIA PROBLEMATICA, sp. nov.

Pl. XXXVIII, Fig. 3.

Leaflet small, oblong or broadly lanceolate, acute, narrowed to the inequilateral base, short petioled; primary nerve narrow; secondaries distant, subopposite, thin, camptodrome.

The leaflet, which is about 4^{cm} long and 1.5^{cm} broad at the middle, has the apex destroyed. Its secondaries, of which there are four pairs, diverge from the midrib at an angle of 40° and are parallel and equidistant, except the lower, which follow close to the borders and are less distant from those above. The inequilateral base shows it to be a leaflet of a compound leaf and its general characters refer it to the genus Cassia, being similar to the leaflets of *C. Berenices* Heer,[1] which is a variable species common in the Miocene of Europe.

Habitat: Ellsworth County, Kansas. No. 453 of the museum of the University of Kansas; E. P. West, collector.

CASSIA POLITA, sp. nov.

Leaflet small, membranous, entire, oval, lanceolate or narrowing from the middle to a blunt apex and downward more rapidly to a short, flat petiole; surface polished; nervation pinnate, camptodrome; secondaries five to six on each side, oblique, parallel, thin, nearly curved in passing toward the borders. It has the size and form of *C. lignitum* Ung. (Syllog., pt. 2, p. 30, Pl. x, Fig. 14), the leaflet being only more equilateral. The veins are thin, mostly simple.

Habitat: Kansas.

[1] Fl. Tert. Helv., vol. 3, p. 118, Pl. CXXXVII, Figs. 42–56.

PALÆOCASSIA LAURINEA, sp. nov.
Pl. LXIV, Fig. 12.

Leaflets lanceolate, subinequilateral, pointed; midrib narrow, but rigid; secondaries parallel, equidistant, arched and camptodrome.

The leaflets are 3^{cm} to 6^{cm} long and 1.5^{cm} broad at or below the middle, narrowed to the base, lanceolate above, and some of them slightly inequilateral. They have the same form and size as those of *P. angustifolia* and *P. lanceolata* Ett.[1] They differ from those of the European species by the nervation being somewhat more distinctly marked, the secondaries, seven to eight pairs, distinctly arched, parallel, and by the somewhat broader size resembling small leaves of some Laurineæ. They may, however, represent the same species.

Habitat: Ellsworth County, Kansas. No. 1117 of the collection of Mr. R. D. Lacoe.

Suborder PAPILIONACEÆ.

Tribe PHASEOLEÆ.

PHASEOLITES FORMUS, sp. nov.
Pl. LV, Figs. 5, 6, 12.

Leaves solid, elliptical, ovate, inequilateral, slightly falcate; midrib strong, gradually narrowed upward; secondaries distinct, thickish toward the base, alternate or opposite, curved and camptodrome; nervilles and areolation indistinct.

The leaves are comparatively large, being 5.5^{cm} to 8^{cm} long and 3^{cm} to 5^{cm} broad at the middle, petioled, with about eight pairs of secondaries at an angle of 50°, which are curved in traversing the blade, camptodrome, somewhat branching in the upper part, forming a simple or double row of areoles along the borders.

The leaves are comparable to *P. glycinoides* Sap.,[2] also to those of the common living *Apios tuberosa*.

Habitat: Ellsworth County, Kansas. Fig. 5 is specimen No. 2796 of the U. S. National Museum.

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[1] Kreidefl. v. Niederschoena, pp. 261, 262, Pl. LII, Figs. 6–8.
[2] Études, vol. 1, pt. 2, p. 100, Pl. XI, Fig. 8.

Tribe GALEGEÆ.

COLUTEA PRIMORDIALIS Heer.

Pl. XIII, Figs. 8, 9.

Fl. Foss. Arct., vol. 6, Abth. 2, p. 99, Pl. XXVII, Figs. 7-11; Pl. XLIII; Figs. 7, 8.

Leaves membranous, short petioled, oval or obovate, entire, rounded in narrowing to the base, emarginate at apex; secondaries very thin, camptodrome.

The leaves, which are 2^{cm} long and 1.5^{cm} broad, are a little shorter, more rounded, and less deeply emarginate than those figured by Heer (loc. cit.). The nervation is of the same type, the secondaries being much curved in passing toward the borders. Fig. 9 represents a leaf of which the lower half only is preserved. It is identified by its nervation and texture.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4040 and 4074 of the collection of Mr. R. D. Lacoe.

LEGUMINOSÆ OF UNCERTAIN RELATION.

LEGUMINOSITES PODOGONIALIS, sp. nov.

Pl. XIII, Fig. 11; Pl. XXXVIII, Fig. 16.

Leaf membranous, elliptical, short petioled, entire, narrowed above to a short, blunt acumen; primary nerve thick, rapidly thinning to the apex; secondaries close, oblique, very thin, parallel and equidistant, camptodrome.

The leaf figured is the only one seen of this character. It is 4^{cm} long and 1.5^{cm} broad in the middle, the thick petiole being only 3^{mm} long. The secondaries, of which there are eight pairs, are subopposite, with a divergence of no more than 30°.

By its form and nervation the leaf is related to *Podogonium americanum* Lesq.,[1] differing essentially by the very thin, slightly more distant secondaries. The leaf is also a little broader in the middle.

Fig. 16 of Pl. XXXVIII apparently represents a seed of some leguminous plant. It is transversely oval, flat but thickish, and comparable to seeds of Podogonium, like those of *P. Knorrii* Heer.[2]

Habitat: Ellsworth County, Kansas. No. 4038 of the collection of Mr. R. D. Lacoe is from ten miles northeast of Delphos, Kansas; No. 874, the

[1] Tert. Fl., p. 298, Pl. LIX, Fig. 5; Pl. LXIII, Fig. 2.
[2] Fl. Tert. Helv., vol. 3, Pl. CXXXV, Figs. 17, 23, etc.

fruiting specimen, is in the museum of the University of Kansas. Collected by E. P. West.

LEGUMINOSITES CORONILLOIDES ? Heer.

Pl. XIII, Fig. 10.

Fl. Foss. Arct., vol. 3, pt. 2, p. 119, Pl. xxxiv, Fig. 14.
Colutea coronilloides Heer, ibid., vol. 6, Abth. 2, p. 100.

Leaves small, oval, short petioled; secondaries very thin, straight or slightly curved

The leaf is slightly smaller than that figured by Heer but of the same form. It seems to differ only by having the lateral nerves more proximate and straight rather than curved, at least in the lower part of the leaf. Heer appears to have seen only a part of the secondaries, as on one side of the leaf they are figured very close, the lowest straight, while on the other side the two pairs figured are distant and curved. In the small leaf from the Dakota Group the lateral nerves are seen with great difficulty and on one side only. Hence it is not possible to ascertain the real character of the nervation. Both this leaf and that of Heer are of uncertain relation. The one which I have figured is comparable also to *Celastrus Bruckmanni* Heer (Fl. Tert. Helv., vol. 3, p. 69, Pl. cxxi, Figs. 27–38).

Habitat: Ten miles northeast of Delphos, Kansas. No. 4035 of the collection of Mr. R. D. Lacoe.

LEGUMINOSITES OMPHALOBIOIDES, sp. nov.

Pl. XXXVIII, Fig. 4.

Leaflet subcoriaceous, short petioled, elliptical, obtuse, attenuated near the base; primary nerve narrow but deeply marked, secondaries very thin, distant, alternate and camptodrome.

The leaflet which is 4^{cm} long and 2^{cm} broad in the middle, is regularly ellipical but narrowed near the base and has six pairs of secondaries at an angle of divergence of 50° curving quite near and along the borders. It has the same form and size as those of *L. Proserpinæ* Heer,[1] which differ only by being slightly emarginate at the apex.

Habitat: Ellsworth County, Kansas. No. 510 of the museum of the University of Kansas. Collected by E. P. West.

[1] Fl. Tert. Helv., vol. 3, p. 123, Pl. cxxxviii, Figs. 50–55.

LEGUMINOSITES DAKOTENSIS, sp. nov.
Pl. XXXVIII, Fig. 5.

Leaflets oval-oblong, rounded to the base, constricted above into a short, pointed acumen (broken); median nerve strong; secondaries oblique, alternate, equidistant, parallel, camptodrome.

The leaflet is 4.5^{cm} long and 2.5^{cm} broad a little above the middle, its broadest part. It has six pairs of thin secondaries which are nearly straight in traversing the blade and diverge at an angle of 40°, curving and anastomosing in simple bows near the borders.

The leaflet, by its size, form, and nervation, is related to species of Cassia and other Leguminosæ described from the European Tertiary, such as *C. Berenices* Heer or *C. Fischeri* Heer.[1] Leaves of this type are described by Ettingshausen (Kreideflora von Niederschoena) as Palæocassia. From the Cretaceous flora of Greenland, Heer has described eleven Leguminosites, besides nine leaflets referred to the genera Cassia, Dalbergia, and Colutea.

Habitat: Ellsworth County, Kansas. No. 552 of the museum of the University of Kansas; E. P. West, collector.

LEGUMINOSITES TRUNCATUS, sp. nov.[2]
Pl. XXI, Fig. 7.

Leaflet membranous, linear, obtuse, emarginate, by inflexion of the border at the apex of the thick, percurrent median nerve; secondaries oblique, close, parallel, curving in passing to the borders, camptodrome, nervilles strong.

This fragment of a leaflet has a broad, flat, median nerve, preserving the same thickness for its whole length. The lateral nervation has some analogy to that of species of Podogonium, especially of *P. Lyellianum* Heer,[3] which represents a leaflet broadly emarginate at the apex. The secondaries are, however, more curved, and ascend higher along the borders.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4075 of the collection of Mr. R. D. Lacoe.

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[1] Fl. Tert. Helv., vol. 3, p. 123, Pl. CXXXVII, Figs. 42–46, 62–65.

[2] This species was called "*Leguminosites emarginatus*, sp. nov.," in the manuscript by Prof. Lesquereux, but this name is preoccupied by Heer's *Leguminosites emarginatus* (Fl. Tert. Helv., vol. 3, 1859, p. 125, Pl. CXL, Fig. 33). I have therefore changed it to *L. truncatus*.—F. H. K.

[3] Fl. Tert. Helv., vol. 3, p. 117, Pl. CXXXVI, Fig. 42.

LEGUMINOSITES CONSTRICTUS, sp. nov.

Pl. XLIV, Fig. 3.

Leaflets small, thin, entire, lanceolate, rounded at base, constricted near the pointed apex; median nerve straight, scarcely narrowed upward; secondaries opposite or alternate, numerous, thin, camptodrome.

This leaf is small, quite smooth and entire, 5.5^{cm} long, 2^{cm} broad below the middle, and resembles in form and size *Cassia hyperborea* Heer,[1] differing in having the secondaries more oblique, diverging 40° or 45° from the midrib, less distant, and by the contraction of the leaf below the apex.

Habitat: Ellsworth County, Kansas. No. 1c of the museum of the University of Kansas; A. Wellington, collector.

LEGUMINOSITES CONVOLUTUS, sp. nov.

Pl. XLIV, Fig. 4.

Leaf small, partly convolute, subcoriaceous, lanceolate, rounded at base and apex; primary nerve thick, nearly equal for its whole length; secondaries thin, numerous, parallel, except the lowest pair, which are at a more acute angle of divergence, camptodrome.

There is only one fragmentary leaf, partly involute, of this species. It is 4^{cm} long, 15^{mm} broad near the base, and has eight or nine pairs of secondaries diverging 45°, or the lowest pair 35°. All are simple, scarcely curving until quite near to the borders, where they anastomose in simple bows. The apex of the leaf is figured as being rounded, as it is seen in its nearly tubulose upper part. It may have been broken or creased and therefore may be incorrectly represented. Nevertheless, by its basilar form and its nervation, the relation of the leaf is marked essentially with the Leguminosæ, for example with *Cassia phaseolites* Heer[2], which has leaves often obtuse at base and apex and an analogous kind of nervation, the median nerve being also generally thick and equal for its whole length. This leaf might also be compared as to its form and size to species of Andromeda, but the leaves of this genus have the secondaries generally parallel and more curved in traversing the blade.

Habitat: Ellsworth County, Kansas. No. 704 of the museum of the University of Kansas; E. P. West, collector.

[1] Fl. Tert. Helv., vol. 3, p. 119, Pl. CXXXVII, Fig. 57.

[2] Fl. Tert. Helv., vol. 3, p. 119, Pl. CXXXVII, Figs. 66, 67; Pl. CXXXVIII, Figs. 1–12.

LEGUMINOSITES CULTRIFORMIS Lesq

Cret. and Tert. Fl., p. 86, Pl. x, Fig. 4.

LEGUMINOSITES INSULARIS Heer.

Pl. LIV, Fig. 4.

Fl. Foss. Arct., vol. 6, Abth. 2, p. 103, Pl. XLIV, Fig. 6.

Leaflets small, oval, acute at apex, entire, inequilateral at base; midrib strong; secondaries numerous, camptodrome.

This leaf differs from that of Heer merely by the pointed apex, at least according to the description, for though the author says that the leaf is slightly obtuse, there is little difference in comparing the figures. As the leaf is slightly larger, the secondaries are more numerous, nine pairs instead of seven, but their character is exactly the same as well as their direction and their degree of divergence from the midrib (40°); they are much curved in traversing the leaf.

Habitat: Near Fort Harker, Kansas. No. 2725 of the U. S. National Museum.

LEGUMINOSITES HYMENOPHYLLUS, sp. nov.

Pl. LV, Figs. 7–9; Pl. LVI, Fig. 3.

Leaves apparently large, consisting of one to several pairs of alternate, oblong-lanceolate pinnules, which are obtuse or truncate-emarginate at apex, and narrowed to the base; secondaries numerous, somewhat curved, incumbent near the borders, camptodrome.

The numerous pinnules evidently belonging to this species, are very similar to those of *H. dakotense* by form and size, being merely somewhat larger and narrower, and apparently truncate-emarginate at apex. The secondaries are more numerous, eleven to twelve pairs, slightly less oblique, at an angle of 50°. The difference is apparently not great; they have, however, a longer common petiole with branches a little below the base of the ultimate leaflets.

Habitat: Kansas.

LEGUMINOSITES PHASEOLITES ? Heer.
Pl. LV, Fig. 10.

Fl. Foss. Arct., vol. 3, Abth. 2, p. 118, Pl. XXXIV, Figs. 7–11.

Leaf short petiolate, elliptical, acuminate; secondaries emerging at an acute angle of divergence, thin, parallel, curved, and camptodrome.

It is not certain that the specimen is referable to this species, which is represented by eleven different leaflets by Heer. He describes the leaflet as inequilateral. All are mere fragments, none being complete, and therefore it is not possible to make a satisfactory comparison. The lower part of our leaflet is oval, as in Fig. 9 of Heer's Pl. XXXIV (loc. cit.); the secondaries are of the same character, but the leaf from Kansas is narrowed upward into a prolonged acumen and its base is equilateral. For this, however, the figures of Heer do not appear inequilateral.

Habitat: Kansas.

INGA CRETACEA, sp. nov.[1]
Pl. LV, Fig. 11.

Leaves long, narrowly lanceolate, gradually acuminate, narrowed at base to a short petiole; midrib narrow; secondaries oblique, mostly opposite, camptodrome.

This leaf, which is preserved entire, is 9^{cm} long and 2^{cm} broad below the middle, has a short, thick petiole 1^{cm} long, is unequal on the sides, and has about fourteen pairs of very oblique secondaries diverging 30° from the midrib and a little curved in passing toward the borders, which they follow in simple festoons. This leaf might be compared to many species of Leguminosites. But the more closely related of those recognized in a fossil state is *I. Icari* Ung. (Fl. v. Kumi, p. 63, Pl. XVI, Fig. 10). There is opposed for comparison a specimen of the living *I. semialata* Mart.

The leaf from the Dakota Group is a little narrower and the secondaries are at a more acute angle of divergence. A number of Tertiary leaves referred by various authors to Cassia have also a great analogy of character with this one, being, however, generally shorter.

Habitat: Near Fort Harker, Kansas. No. 2767 of the U. S. National Museum.

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[1] This species was figured and described under the name of "*Leguminosites Ungeri*, sp. nov.," but in a list of Dakota group plants purchased for the U. S. Geological Survey and sent by Prof. Lesquereux at a later date than that on which work on the manuscript occurred, the type specimen is named *Inga cretacea*. It is therefore clear that his intention was to change it from its problematical position under Leguminosites to the more definite position under Inga, and I have done so.—F. H. K.

Order ANACARDIACEÆ.

Tribe SPONDIEÆ.

RHUS ? WESTII, sp. nov.[1]
Pl. XXXVIII, Figs. 9, 10.

Leaves lanceolate, acuminate, enlarged and rounded at the base; secondaries parallel, oblique, camptodrome.

Two fragments of uncertain relation. The leaves, which taper upward from the rounded base, are apparently acuminate, the secondaries being simple, a little curved in traversing the blade, and anastomosing in simple bows quite near the borders, diverging from the primary nerve at an angle of 40° to 50°.

These fragments appear similar to the leaves of *R. deleta* Heer (Fl. Tert. Helv., vol. 3, p. 83, Pl. CXXVII, Fig. 8). But as the lower part of the fragments of the leaves from Kansas is destroyed, their form is uncertain. An appreciable difference is remarked in the more open secondaries of Heer's species.

Habitat: Ellsworth County, Kansas. Nos. 513 and 514 of the museum of the University of Kansas. Collected by E. P. West.

RHUS UDDENI, sp. nov.
Pl. LVII, Fig. 2.

Leaves compound, pinnately divided into coriaceous, opposite, sessile, lanceolate, entire leaflets, the lower decurring along the main rachis into narrow borders or wings; midrib strong; secondaries oblique, numerous, simple, camptodrome.

The specimen represents a fragment of a compound leaf with three pairs of opposite leaflets, attached to a main branch or rachis, winged as seen in its upper part, the wing being mostly erased in the lower part, which is not very well preserved. The upper leaflets are destroyed from the middle up, but the forking of the midrib shows a division of the terminal leaflet into two lobes like that seen in the preceding species. The secondaries, which are 3^{mm} distant at the base, emerging from the midrib at an angle of 30°, are simple, parallel, equidistant, very strong, camptodrome, somewhat curved in passing toward the borders.

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[1] This species was named "*Rhus ambigua*, sp. nov.," by Prof. Lesquereux, but this specific name is already preoccupied by the *Rhus ambigua* of Unger (Bot. Zeit., 1849, No. 19, p. 352, Pl. v, Fig. 9), and I have changed it to *Rhus Westii* in honor of the collector.—F. H. K.

This species, like the preceding one, has a marked analogy with the leaves of *R. copallina* L., the dwarf sumach of the northeastern part of the United States, and allied species, especially *R. virens* Lindh., the leaves of which are sometimes coriaceous. The form of its sessile, entire leaflets is the same as well as the direction of the numerous secondaries.

Habitat: Kansas. Specimen presented to the U. S. National Museum by J. A. Udden.

RHUS POWELLIANA, sp. nov.

Pl. LVI, Figs. 4, 5.

Leaves large, compound, lanceolate, alternately divided into petiolate lanceolate, blunt-pointed leaflets of thin texture, the terminal larger, bilobate from the middle, those of the lower pair also short lobate at the base or subdivided into narrower, shorter pinnules; primary nerves thick; secondaries simple, numerous, parallel, camptodrome; main rachis round, and like the rachis of the pinnules, not winged.

The fragments preserved are part of large, compound leaves, the best of which, figured here, has three pairs of lateral pinnules with the terminal one lobate. The pinnules are oblique, parallel, alternate, 2^{cm} to 3^{cm} distant, at least 9^{cm} to 11^{cm} long, 2^{cm} to 2.5^{cm} broad at the middle, with borders slightly undulate or repand. The midribs are thick and pass downward into a round petiole of the same thickness, about 1^{cm} long, cylindrical, not winged. The secondaries emerge with the same angle of divergence of 30°, and are somewhat curved in passing toward the borders, all being simple.

The fragment (Fig. 5) is part of a much larger leaf of which only the terminal leaflets remain, with the upper part of two lateral ones. It has the same character, the terminal leaflet being bilobate in the upper part by the forking of the midrib near the base.

This fine species is related to *R. juglandogene* Ett., as figured by Saporta in Études, vol. 2, Pl. XIII, Fig. 2b, the leaves of which are, however, sessile and dentate.

On this last quotation Schimper remarks that the leaves appear rather to be those of a Sapindus, especially on account of their entire borders.

Habitat: Near Fort Harker, Kansas. No. 2691 of the U. S. National Museum.

ANACARDITES ANTIQUUS, sp. nov.
Pl. LVII, Fig. 1.

Leaf large, coriaceous, oblong, pointed, rounded and abruptly narrowed at base to the midrib, petiolate; midrib solid; secondaries thick, close, parallel, the lowest at right angles, the upper gradually more oblique, craspedodrome.

A mere fragment, but very distinct and well preserved on account of the hard, coriaceous substance of the leaf. It is 9^{cm} long, 5^{cm} broad, and has eleven pairs of alternate secondaries about 1.5^{cm} distant, some of them being variable in distance and more or less oblique to the midrib, according to their position, almost all forking once near the borders. The stout midrib is straight and descends as a solid petiole, broken 2^{cm} below the base of the leaf.

A more distinct point of affinity with this leaf is found in species of Anaphrenium, figured in Ettingshausen's Blattskelete der Dikotyledonen, one of which, *A. longifolium* Bernh.,[1] though a smaller leaf, appears to represent the essential character of the fragment of the Dakota Group, the leaf being small, linear oblong, obtuse at base and apex, and has strong secondaries at right angles and at a short distance, forking once near the borders and acrodrome.

Habitat: Near Fort Harker, Kansas. No. 2764 of the U. S. National Museum.

Order ACERACEÆ.

NEGUNDOIDES ACUTIFOLIUS Lesq.

Cret. Fl., p. 97, Pl. XXI, Fig. 5.

ACERITES MULTIFORMIS, sp. nov.
Pl. XXXIV, Figs. 1-9.

Leaves subcoriaceous, petioled, more or less distinctly tripalmately lobed, cuneate, rounded or cordiform at base; lateral lobes either long, entire, obtuse, lobate-dentate at apex, or short and obtuse, open or oblique; median nerve a little thicker than the lateral ones, these much branching outside and passing up to the points of the lobes; secondaries emerging far above the primaries, more or less distant, parallel, curved and camptodrome like the branches of the primaries; nervilles distinct, at right angles to the nerves, broken or interrupted at the middle.

[1] Loc. cit., p. 179, Pl. LXXVII, Fig. 10.

The form and size of these leaves is so variable that at first sight they appear referable to three or four different species. But in comparing the characters in each of the leaves it does not seem possible to separate them. In all of them the lateral primary nerves are supra-basilar, having a pair of thin, marginal veinlets underneath and distinct, except in Fig. 9. The lobes, passing from those of the longer leaves (Figs. 1 and 2), where they are very short and very obtuse, become longer and more open in Fig. 4, and still longer and narrower in Figs. 3, 6, and 7, then enlarged at their outer end, and there lobed, as in Fig. 5.

The nervation being the same in all the leaves, the outlines are so gradually modified that the separation of one of them would necessitate the admission of a specific name for each.

The most distinct in form are those of Figs. 8 and 9. Fig. 8, although of the same type of nervation as the others, is, from the teeth of the upper part, perhaps nearer to *Parrotia grandidentata* of Pl. XX, but the nervation is different. Fig. 9 has the secondaries basilar and no traces of a thin nerve underneath. But the base of the leaf is curved into the stone and the general character is the same as in Figs. 1 and 2. Differences of this kind are often remarked in the leaves of living species of Acer.

The relation of this leaf is marked with *Acer antiquum* Ett.,[1] a leaf in which the lateral primaries emerge from the base, though the subdivision of the lobes is of the same character as in Fig. 7 of our plate. The author compares his leaf to *A. decipiens* Heer,[2] a species with trilobate leaves, and entire, acute or acuminate lobes, the primary nervation basilar. Possibly the supra-basilar nervation of these leaves might be considered as against the reference of this species to Acer; but the same disposition is observed in the primary nerves of a number of species of the genus in *A. pseudo monspessulanum* Ung. (Chlor. Prot., Pl. XLIII, Fig. 2), *A. pseudocampestre* Ung. (ibid., Fig. 7), *A. obtusilobum* Ung. (ibid., Fig. 12), species which have entire leaves and like the Cretaceous leaves, sometimes a thin pair of basal nerves under the primaries. Still the same character is seen in many of the leaves figured by Heer in his Fl. Tert. Helv., and especially in *A. indivisum* Web. (Tertiärfl. Niederrh. Braunkohlenform., Pl. V, Fig. 2), and *A. vitifolium* Ludwig (Foss. Pfl. Rhein.-Wett. Tertiär-Form., Pl. LII, Fig. 1). Hence the supra-basilar distribution of the lateral primaries can not eliminate these leaves from the genus Acer. It is true that as yet, with the exception of

[1] Kreidefl. v. Niederschoena, p. 259, Pl. III, Fig. 17.

[2] Fl. Tert. Helv., vol. 3, p. 58, Pl. CXVII, Figs. 15–22; Pl. CLV, Fig. 12.

Ettingshausen's species, which some botanists consider as of hypothetical reference, no leaf of Acer has been described from the Cenomanian. But before the plants of the Dakota Group and those of the Cretaceous of Greenland had been discovered, the same remark could have been made with reference to most of the genera now well ascertained in that formation. A closely allied genus, Sapindus, is represented by different species in the Cenomanian of Greenland and of North America, and I do not see why the origin of the genus Acer could not be admitted as possible in that formation.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4078, 4079, 4080, 4082, etc., of the collection of Mr. R. D. Lacoe.

Order SAPINDACEÆ.

Tribe SAPINDEÆ.

SAPINDUS MORRISONI Lesq.

Pl. XXXV, Figs. 1, 2.

Cret. and Tert. Fl., p. 83, Pl. XVI, Figs. 1, 2; Heer, Fl. Foss. Arct., vol. 6, Abth. 2, p. 96, Pl. XL, Fig. 1; Pl. XLI, Fig. 3; Pl. XLIII, Figs. 1a, b; Pl. XLIV, Figs. 7, 8.

Leaves compound, pinnate; leaflets subcoriaceous, entire, lanceolate, unequal at the round, cuneate base; secondaries numerous, curved, camptodrome.

The two leaves figured here are slightly smaller than those in Cret. and Tert. Fl. (loc. cit.), but of the same character. The difference in size is more marked in the leaves figured by Heer, especially in those of Pl. XLIV, Figs. 7, 8. *S. prodromus* Heer[1] has the leaves smaller, subfalcate, and the secondaries closer and more numerous.

Habitat: Pipe Creek, Cloud County, Kansas. Nos. 4087 and 4094 of the collection of Mr. R. D. Lacoe.

SAPINDUS DIVERSIFOLIUS, sp. nov.

Pl. LXIV, Fig. 18.

Leaflets very variable in size and form, short, oval, obtuse or lanceolate from above the middle, 4^{cm} to 11^{cm} long, 2^{cm} to 5^{cm} broad, the largest apparently terminal and obovate, all with borders entire; strongly nerved; midrib

[1] Fl. Foss. Arct., vol. 3, pt. 2, p. 117, Pl. XXXIV, Fig. 5; vol. 6, Abth. 2, p. 96, Pl. XXV, Fig. 5b; Pl. XXVI, Fig. 5a.

stout and broad; secondaries at an open angle of divergence, distinctly camptodrome and curved in traversing the lamina. The species is closely allied to *S. apiculatus* Velen. (Fl. böhm. Kreide., pt. 3, Pl. VII, Figs. 1–8).

Habitat: Ellsworth County, Kansas. No. 721 of the collection of Mr. R. D. Lacoe.

Order AMPELIDACEÆ.

Tribe AMPELIDEÆ.

CISSITES INGENS, sp. nov.

Pl. XIX, Figs. 2, 2a.

Leaves large, palmately deeply tri-five lobate; lateral lobes broad, lobate and dentate; the median short, enlarged above, simply dentate; divisions acute; primary nerves, three or five, thick, the lateral forking near the base or branching above into thinner tertiaries, all the divisions ascending to the teeth.

Some of the leaves, as seen from the fragment (Fig. 2a), which is only a lateral lobe, were at least 28^{cm} to 30^{cm} in width between the extremities of the lateral lobes. The smaller leaf (Fig. 2), preserved entire, differs in the lateral primaries joining the petiole by their base and not forking above it

The species is of the same type as *C. formosus* Heer, described below, *C. insignis* Heer[1] and *C. puilasokensis* Heer[2] described from Puilasok, a Miocene stage. It has also a degree of relation to *Cissus vitifolia* Velen.[3]

Of these species it differs essentially in the size and the acute form of the divisions or teeth of the leaves and by the position of the lateral primaries near the basal border of the leaves, which in all those described by Heer join the median nerve at right angles as in *C. formusus* (Pl. XXI, Fig. 5).

This character was apparently the same in the large fragment which is represented in Fig. 2a, the lateral primaries branching above their points of union to the median nerve and joining it above its base.

Habitat: Ellsworth County, Kansas. No. 591 of the collection of the University of Kansas; E. P. West, collector. No. 2737 of the U. S. National Museum.

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[1] Phyll. Crét. du Nébr., p. 19, Pl. II, Figs. 3, 4.
[2] Fl. Foss. Arct., vol. 7, p. 119, Pl. CVII, Figs. 8–10.
[3] Fl. böhm. Kreide., pt. 3, Pl. II, Fig. 6.

CISSITES INGENS Lesq. var. PARVIFOLIA, n. var.
Pl. LVII, Figs. 3, 4.

These two leaves represent a small form of the species. Though having evidently the same general characters, Fig. 2, Pl. XIX, shows the union of the primary nerves at a point far above the basal border of the leaf and the lobes and their subdivisions are broader and shorter.

Fig. 3 has the lobes narrower, more deeply cut, the nervilles oblique and more distinct, and the union of the primaries above the base of the leaf. The fragment 2a of Pl. XIX appears to have had the point of union of the primaries still higher than Fig. 2, or as it is in the reconstructed figure of *C. formosus* Heer (Fl. Foss. Arct., vol. 6, Abth. 2, Pl. XXI, Fig. 8). The numerous leaves of *C. ingens* show this disposition to be merely casual.

Habitat: Near Fort Harker, Kansas. No. 2737 of the U. S. National Museum.

CISSITES ALATUS, sp. nov.[1]
Pl. XXIII, Fig. 6.

Leaf small, thickish, with smooth surface, deeply palmately trilobate; lateral lobes at right angles, long-obovate or enlarged to an obtuse apex, the median nerve broader and shorter, enlarged, truncate and obtusely short trilobate at apex; primary nerves palmately trifid, the lateral supra-basilar, nearly at right angles, branching on both sides; secondaries at a distance from the primary ones, two or three pairs entering the upper lobes, all branching like the lateral primaries in camptodrome divisions.

The form of this leaf is remarkable, being like a combination of Aralia with Liriodendron or with Platanus, like *P. obtusiloba* Lesq. (Cret. Fl., Pl. VII, Fig. 3), having the same character of nervation and about the same disposition of the lobes as this last species. The basilar lobes are, however, much longer, and the apex of the leaf is enlarged and trilobed, presenting altogether the facies and the essential characters of *C. formosus* Heer, as figured on Pl. XXIII, Fig. 6 (loc. cit.).

Habitat: Ten miles northeast of Delphos, Kansas. No. 4034 of the collection of Mr. R. D. Lacoe.

[1] This species was later compared by Prof. Lesquereux to *Liriodendron Gardneri* Sap. (Origine Pal. des arbres cult. ou utilisés par l'homme, p. 269, text, Fig. 1), but there is no further indication that he intended to transfer it to Liriodendron. A comparison of the two figures shows a very great similarity, the principal difference being the supra-basilar position of the lateral primaries in *C. alatus*.—F. H. K.

CISSITES FORMOSUS Heer.
Pl. XXI, Fig. 5.

Fl. Foss. Arct., vol. 6, Abth. 2, p. 85, Pl. XXI, Figs. 5–8.

Leaves palmately, deeply trilobate, entire; median lobe contracted in the middle, trilobate; lobes obtuse.

This is the description of Heer, who had seen only small fragments of this species, but has reconstructed a fine, whole leaf according to the characters of the fragments. The part we have now is far better preserved than any of those figured by Heer. The median nerve is thick, with two primary, opposite, lateral, supra-basilar nerves, one of which is forked quite near its base, and the lobe is accordingly bilobate; the other is simple, undivided, and the lobe entire. The upper lobe is enlarged and evidently divided into three small lobes on each side; at least it has three pairs of thin secondary nerves, which ascend obliquely, but straight, one of them reaching the point of a small lobe or round tooth. Except these three pairs of secondaries in the upper part of the leaf there is no nervation marked above or below the primaries. On the contrary, in Heer's specimen the secondaries appear much lower, as low as the sinuses, and in ascending form apparently successive lobes on the side of the upper division, which is thus more elongated than it could be in our leaf, which differs also by having the lateral lobes less oblique, nearly at right angles to the median nerve, and the sinuses broader.

Habitat: Ellsworth County, Kansas. No. 9 of the museum of the University of Kansas. Collected by A. Wellington.

CISSITES OBTUSILOBUS, sp. nov.[1]
Pl. XXXIII, Fig. 5.

Leaf small, thickish, fan-shaped or semilunar, rounded to a long petiole, abruptly decurring to it at its very base, subtruncate and obtusely short-lobate or rather undulate at apex, palmately trinerved from above the base, with two pairs of secondary nerves parallel; craspedodrome.

The leaf has a close affinity of characters with *C. harkerianus* Lesq. (Cret. and Tert. Fl., p. 67, Pl. III, Figs. 3, 4). It might possibly be considered a form allied to *C. Heerii* Lesq. (Cret. and Tert. Fl., p. 68, Pl. V, Fig. 2).

[1]Prof. Lesquereux wrote later of this species as follows: "Velenovský in his Flora böhm. Kreideformation, pt. 2, Pl. VI, Fig. 2, has a figure like this (*Cissites obtusilobus*, sp. nov., Pl. XXXIII, Fig. 5), and has named it *Liriodendron Celakovskii*; it essentially differs by the lateral primaries being basilar."—F. H. K.

It is 3^{cm} long from the top of the petiole to that of the median nerve and nearly 5^{cm} broad between the lateral, obtuse lobes, subemarginate by contraction of the lamina at the apices of the primary nerves. The petiole is 2^{cm} long; the secondaries, of which there are two pairs, are thin, opposite, the upper ones corresponding to the intermediate, short, obtuse, subapicial lobes. There is at the base a very thin, marginal nerve following the borders, with which lower, thin branches of the primaries, like nervilles, anastomose, forming a continuous series of bows along the lower borders.

Habitat: Ellsworth County, Kansas. No. 48 of the collection of the University of Kansas; A. Wellington, collector.

CISSITES POPULOIDES, sp. nov.
Pl. XVIII, Fig. 12–14.

Leaves thin, comparatively small, ovate or broadly cuneiform, subcordate at the base, obtuse, entire, long petioled; nervation subtripalmatifid from the base; median nerve thick; lateral primaries thin, branching on the under side, parallel to the secondaries, of which there are four or five pairs, equidistant, opposite, simple or forking near the borders, subcraspedodrome.

The leaves are from 2.5^{cm} to 4^{cm} long and from 3^{cm} to 3.5^{cm} broad, enlarged above the base, rounded to the apex or oblong and obtuse, with a petiole 1^{cm} long, appearing broken. The angle of divergence of the nerve is 50°.

This species has the peculiar nervation of the Cretaceous leaves referred to Populites. The nervation is apparently tripalmate, but the primary lateral nerves are quite thin, like the secondaries, and merely differ from them by their position and their branches. The nervation is craspedodrome, but the nerves, which are simple or forking near the borders, are not quite distinctly seen entering them, but vanishing to them as in species of Cissites.

Habitat: Ten miles northeast of Delphos, Kansas. Nos. 4137 and 4183 of the collection of Mr. R. D. Lacoe.

CISSITES BROWNII Lesq.
Pl. XVIII, Fig. 11.

Geol. Rept. of Minnesota, by Prof. N. H. Winchell (unedited).

Leaves coriaceous, oval, angularly undulate or sublobate, entire, obtuse at apex; broadly cuneate at base and joining the petiole by a short, inward curve, penninerved. Primary nerves straight, half cylindrical; secondaries half open, alternate, parallel, rigid, scarcely curved in traversing the blade, forking near the borders, craspedodrome with their divisions; nervilles deep, at right angles to the nerves; areolation small, quadrate, very distinct.

Though the shape and the dimensions of the leaves are variable, the peculiar type of nervation remains the same in all the leaves I have seen of this species. The lateral primaries are joined to the median nerve at a short distance above the basal borders of the leaves; the secondaries are comparatively numerous, consisting of seven pairs, in a leaf a little more than 6^{cm} long, diverging 30° or 40° and forking once or twice quite near the borders. In some specimens the lateral primaries are ramose on the lower side.

The leaves of this species have a degree of relation to those of *C. Nimrodi* and *C. atlantica* Ett. (Flora v. Bilin, pt. 3, pp. 3, 4, Pl. XL, Figs. 3–10), at least in the character of the nervation, and especially to Figs. 7 and 8 (loc. cit.), but the secondaries are less numerous, and though the shape of the leaves is quite variable, none of those figured are comparable to that of our plate.

Habitat: Kansas, Minnesota, etc. No. 4173 of the collection of Mr. R. D. Lacoe. The leaf is similar to that figured from Prof. N. H. Winchell's collection.

CISSITES ACERIFOLIUS, sp. nov.
Pl. LVIII, Fig. 1.

Leaf of medium size, thickish, regularly five-lobed and palmately five-nerved from the base, the upper or terminal lobe ovate, blunt pointed; upper lateral oblique, somewhat long, blunt pointed, the lower short angular; midrib and upper lateral primaries of medium size branching, the branches curved and camptodrome, lower primaries, thin, simple.

The leaf is ovate-cordate in outline, five-nerved from the top of the petiole and five-lobed, the lobes quite entire, the lower or basilar ones curving down and rounding lower than the top of the petiole, forming thus a deeply emarginate or cordate leaf.

The median and the upper lateral nerves are stronger and obliquely branching, with secondaries oblique, straight or curved; no trace of areolation is seen.

Habitat: Near Fort Harker, Kansas. No. 2750 of the U. S. National Museum.

CISSITES DENTATO-LOBATUS, sp. nov.
Pl. LXVI. Fig. 4.

Leaf cordate in outline, enlarged in the lower part, irregularly dentate-lobate, trilobate above the middle, the lobes irregular, enlarged above, obtusely dentate or irregularly lobed toward the apex; median lobe prolonged upward; narrowed in the middle toward the obtuse sinuses.

This leaf is very peculiar in its multiple division. It is 9^{cm} long, 8^{cm} broad near the base, trilobate from the middle, the two lateral lobes broader, one of them partly dentate and lobed, the other four or five deeply, obtusely lobed, the middle narrower and enlarged above, and these irregularly divided into five obtuse, short lobes, one only obliquely prolonged. The peculiar form of the leaf can not be understood without figures. It has a distant affinity to the fragment described as *Cissus vitifolia* Velen. (Flora böhm. Kreidefl., pt. 3, p. 8, Pl. II, Fig. 6).

Habitat: Ellsworth County, Kansas. No. 660 of the collection of Mr. R. D. Lacoe.

CISSITES SALISBURIÆFOLIUS Lesq.

Sassafras obtusum Lesq., Cret. Fl., p. 81, Pl. XIII, Figs. 2, 3.
Populites salisburiæfolius Lesq., Am. Journ. of Sci. and Arts, ser. 2, vol. 46, 1868, p. 94.

CISSITES HARKERIANUS Lesq.

Cret. and Tert. Fl., p. 67, Pl. III, Figs. 3, 4.
Sassafras (Araliopsis) harkerianum Lesq., Cret. Fl., p. 81, Pl. XI, Figs. 3, 4; Pl. XXVII, Fig. 2. Hayden's Ann. Rept., 1874, p. 352, Pl. VII, Figs. 1, 2.

CISSITES AFFINIS Lesq.

Cret. and Tert. Fl., p. 67.
Platanus affinis Lesq., Cret. Fl., p. 71, Pl. IV, Fig. 4.

CISSITES ACUMINATUS Lesq.

Hayden's Ann. Rept., 1874, p. 353, Pl. VIII, Fig. 1; Cret. and Tert. Fl., p. 67, Pl. V, Figs. 3, 4.

CISSITES HEERII Lesq.

Hayden's Ann. Rept., 1874, p. 353, Pl. VI, Fig. 3; Cret. and Tert. Fl., p. 68, Pl. V, Fig. 2.

AMPELOPHYLLUM ATTENUATUM Lesq.

Hayden's Ann. Rept., 1874, p. 354, Pl. II, Fig. 3; Cret. and Tert. Fl., p. 68, Pl. II, Fig. 2.

AMPELOPHYLLUM OVATUM Lesq.

Cret. and Tert. Fl., p. 69; Hayden's Ann. Rept., 1874, p. 355.
Celtis? ovata Lesq., Cret. Fl., p. 66, Pl. IV, Figs. 2, 3.

Order RHAMNEÆ.

Tribe ZIZYPHEÆ.

PALIURUS CRETACEUS, sp. nov.
Pl. XXXV, Fig. 3.

Leaves subcoriaceous, broadly rhomboidal, rounded, undulate above, narrowed to the base, triplenerved; lateral primaries basilar, oblique, straight to near the apex, with few branches; secondaries, two pairs, alternate, open at a great distance from the base.

The leaf, which is 5^{cm} long and 4^{cm} broad, is undulate from the middle upward, cuneate to the base, with the median nerve a little stronger than the lateral ones, which ascend to the borders at an angle of 20° from the median nerve. The relation of this species is with *P. affinis* Heer (Fl. Foss. Arct., vol. 7, p. 42, Pl. LXII, Figs. 16–19). Heer's Fig. 16 (loc. cit.), represents a leaf from Patoot which is finely preserved with its petiole. The leaf from the Dakota Group differs from it by the more enlarged obtuse shape, and the less numerous branches of the lateral primaries.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4079 of the collection of Mr. R. D. Lacoe.

PALIURUS OBOVATUS, sp. nov.
Pl. XXXV, Fig. 6.

Leaves coriaceous, entire, obovate, rounded at apex, narrowly wedgeform to the base, triplenerved, median nerve slightly thicker than the lateral ones, excurrent into a short mucro; lateral primaries straight, oblique, ascending to near the apex, with few branches; one of the secondaries only visible, short, curved.

The leaf is 4^{cm} long and 4^{cm} broad above the middle. It is as yet without any known relation. As in the following species the primaries have scarcely any branches and the place of the secondaries is indicated near the apex by a single, short, curved one. From the nervation only the leaf is comparable to *P. tenuifolius* Heer[1] of the Miocene, which has small oval

[1] Fl. Tert. Helv., vol 3, p. 76, Pl. CXXII, Fig. 31.

or ovate leaves of thin texture. It has also a distant affinity to *P. membranaceus* Lesq.,[1] from which it differs by its texture and nervation.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4143 of the collection of Mr. R. D. Lacoe.

PALIURUS OVALIS Dawson.

Pl. XXXV, Fig. 7.

Mesozoic Fl. Rocky Mountain Region, Trans. Roy. Soc. Canada, sec. IV, 1885, p. 14, Pl. IV, Figs. 4, 8.

Leaf not thick, flat, exactly elliptical, blunt at the base and the apex, triple nerved; median nerve thick, percurrent; lateral primaries short, close to the borders, slightly curved, reaching to half the leaf, effaced there, simple or scarcely branching.

The leaf, which is 4.5^{cm} long and 2^{cm} broad, apparently does not differ from that from Canada (Fig. 4, loc. cit.). But the author says of the leaves that they are coriaceous, while the one figured here appears rather thin.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4142 of the collection of Mr. R. D. Lacoe.

PALIURUS ANCEPS, sp. nov.

Pl. XXXV, Fig. 4.

Leaves subcoriaceous, ovate, tapering upward to a blunt apex, narrowed in rounding to the base, triple or obscurely five-nerved; primary lateral nerves oblique, straight, and reaching the borders above the middle; secondaries two pairs, opposite, camptodrome.

The leaf is comparable to that of the following species, from which it differs by the absence of the lateral lobes and of tertiary nervilles; by the few secondaries, only two pairs, and by a very thin basilar vein, which, though not very distinct, is traced upon the figure quite near and along the border. It is also a little larger; but as it has the same texture and the same general appearance, it may be a peculiar form of the same.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4141 of the collection of Mr. R. D. Lacoe.

[1] Cret. Fl., p. 108, Pl. XX, Fig. 6.

PALIURUS MEMBRANACEUS Lesq.
Pl. XXXV, Fig. 5.

Cret. Fl., p. 108, Pl. xx, Fig. 6.

Leaf small, subcoriaceous or membranous, oval, obtusely pointed, short-obtusely lobate near the apex, narrowed-cuneiform to the base, triple nerved; lateral primaries strong, oblique, ascending to the lobes, branching outside, anastomosing, with nervilles at right angles from the median nerve; secondaries consisting of four pairs, proximate, camptodrome.

Perhaps this leaf represents a different species from that in Cret. Fl. (loc. cit.). It is a little smaller, less broadly obtuse at the apex, has the two small lateral lobes more marked and the base more narrowly cuneate. Though these differences may be observed, the secondary nervation being of the same type and the presence or absence of upper lateral small lobes or teeth being frequently observed in species of this genus, as for instance in *P. Colombi* Heer, of which the numerous figures show more marked differences than are seen between these two Cretaceous leaves, it seems right to refer them to the same species.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4068 of the collection of Mr. R. D. Lacoe.

ZIZYPHUS DAKOTENSIS, sp. nov.
Pl. XXXVI, Figs. 4-7.

Leaves subcoriaceous, petioled, narrowly elliptical, rounded or decurring at base in narrowing to the petiole, tapering upward to an acute apex, equilateral, distantly, sparingly dentate on the borders; five-nerved from the base. There are four fragments of leaves, one preserved nearly entire, 7.5^{cm} long, 15^{mm} broad below the middle, the others much larger, the upper part destroyed, being about twice as long, 2.5^{cm} broad. The teeth of the borders are distant, cut at right angles and blunt at apex. The median nerve, which is enlarged at base to a petiole nearly 2^{cm} long, is comparatively long, the inner lateral nerves being distinct though thin, ascending to two-thirds the length of the leaves, parallel to the borders, branching outside in very thin tertiaries, anastomosing in areoles with an outer, shorter marginal nerve, joined by very thin inside nervilles, transversely passing out from the midrib.

This fine species has no close analogy with any of the published fossil species, the nearest relative being *Z. undulatus* Ett.[1], representing in three

[1] Fl. v. Sagor, pt. 2, p. 196, Pl. XVI, Figs. 4-6.

fragments a long, lanceolate acuminate leaf, differing especially in the borders, which are merely undulate, and the lateral primaries, which are more distant from the midrib and distinctly acrodrome. *Z. Ungeri* Heer[1] and *Z. ovatus* Web.[2] are also related to this species.

Habitat: Ellsworth County, Kansas. Nos. 84, 84a, 730, and 1000 of the museum of the University of Kansas. Collected by A. Wellington and E. P. West.

Tribe RHAMNEÆ.

RHAMNUS SIMILIS, sp. nov.

Pl. XXXV, Figs. 12, 13.

Leaves coriaceous, entire, lanceolate, gradually narrowed to the base, and more abruptly in the upper part to a blunt apex; nervation deeply marked, median nerve strong; secondaries at an acute angle of divergence, unbent but curving close to the borders, camptodrome.

The leaves are about 9^{cm} long and 3^{cm} broad at the middle, and are thick, with recurved borders; the secondaries are numerous, parallel, equidistant, with few branches, passing straight toward the borders at an angle of divergence of 30°, and curve abruptly along them, with close, broken nervilles at right angles. The leaves are much like those of *R. rectinervis* Heer,[3] merely differing in the borders being entire, the coriaceous texture with the secondaries less distant and thus more numerous. They have also a marked affinity to those of the living *Frangula caroliniana* Gray, by their form and by the recurved borders; and still, by the closeness of the secondaries, to those of *R. Purshianus* DC. A degree of relation is also remarked with what Dunker has published in Palaeontographica, vol. 4, 1859, p. 182, Pl. XXXIV, Fig. 3, as *Cytisus cretaceus*, a species with leaves of the same size and form as that of Fig. 12, with secondaries close, parallel, but curved in passing toward the borders.

Habitat: Ellsworth County, Kansas. Nos. 209 and 210 of the collection of Mr. R. D. Lacoe.

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[1] Fl. Tert. Helv., vol. 3, Pl. CXXII, Figs. 25, 25b.
[2] Palaeontogr., vol. 6, p. 141, Pl. LVIII, Fig. 13.
[3] Fl. Tert. Helv., vol. 3, p. 80, Pl. CXXV, Figs. 2–6.

RHAMNUS PRUNIFOLIUS Lesq.[1]
Pl. XXXV, Fig. 14.

Cret. and Tert. Fl., p. 85.

Leaves small, subcoriaceous, ovate-lanceolate, rounded in narrowing to the base, entire, acute or acuminate (point broken); median nerve thick, straight; secondaries numerous, twelve to fifteen pairs, parallel, camptodrome.

Of this species I have seen only the fragment figured. It represents a leaf 5^{cm} to 6^{cm} long, 2.5^{cm} broad at the middle, with numerous secondaries diverging at an angle of 50° to 60° at their base, much curved in traversing the blade, arched close to the borders, forming a simple series of bows by anastomosing upon each other, and obliquely cut by transverse, close, distinct, mostly simple, and continuous nervilles, at right angles to the midrib.

The leaf is comparable to *Salix nervillosa* Heer,[2] especially for the direction of the close, simple nervilles. But this last leaf has the secondaries comparatively more distant, somewhat branched, especially at a more acute angle of divergence, and the leaf, which is more narrowly lanceolate, is narrowly cuneiform to the base. By the same character it has a degree of likeness to that of *Ficus psidiopsis* Massal.,[3] differing from it in the leaves not being subcordate but attenuated at the base and the secondaries without branches.

Habitat: Kansas. No. 479 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

RHAMNUS MUDGEI, sp. nov.
Pl. XXXVII, Figs. 2, 3.

Leaves coriaceous, oval, rounded and pointed to the apiculate apex, narrowing to a short, thick petiole by an outward curve: secondaries numerous, parallel, a little curved in passing to the borders, camptodrome.

Two leaves varying in length from 4.5^{cm} to 7^{cm}, and from 2^{cm} to 3^{cm} broad at the middle, with entire borders; primary nerve stout, enlarged at

[1] No. 709 of the collection of Mr. R. D. Lacoe was referred to this species by Prof. Lesquereux with the following remarks: "*Rhamnus prunifolius* Lesq., No. 709 of Lacoe's collection, is a leaf of this species. It is a little larger, more narrowed to the base; the secondaries at a slightly more acute angle of divergence, some of them flexuous, turning downward at base in joining the midrib. The nervilles are of a normal position, at right angles to the midrib."—F. H. K.

[2] Phyll. Crét. du Nébr., p. 15, Pl. I, Fig. 3.

[3] Massalongo and Scarabelli, Fl. Foss. Senigall., p. 229, Pl. I, Figs. 15, 16; Pl. XXVI, Fig. 2.

base to a short petiole; secondaries consisting of ten to twelve pairs diverging at an angle of 50° to 55° from the midrib, a little curving in traversing the blade, arched along and near the borders without osculating in festoons.

I have no point of comparison for these leaves. The nervation is much like that of *R. tenax* Lesq., but the leaves have a far different aspect and the angle of divergence of the secondaries is twice as broad.

Habitat: Ellsworth County, Kansas. Nos. 793 and 794 of the museum of the University of Kansas; E. P. West, collector.

RHAMNUS TENAX Lesq.

Pl. XXXVIII, Fig. 6.

Cret. Fl., p. 109, Pl. XXI, Fig. 4.

The leaf is merely a little smaller than *R. Mudgei* described above, but identical in all the characters.

Habitat: Ellsworth County, Kansas. No. 791 of the museum of the University of Kansas; E. P. West, collector.

RHAMNUS INÆQUILATERALIS, sp. nov.

Pl. XXXVII, Figs. 4–7.

Leaves subcoriaceous, entire, broadly or narrowly lanceolate, acuminate, narrowed and decurring to a short petiole, inequilateral, curved to one side or subfalcate; primary nerves narrow; secondaries at an acute angle of divergence, camptodrome.

These leaves, though related to the following species, especially in their nervation, are more variable in length, being from 3.5^{cm} to 8^{cm} long, and from 1^{cm} to 3.5^{cm} broad, tapering up to an acumen, attenuated to the base in the same degree and slightly decurrent in reaching the petiole. The secondaries, diverging at an angle of 20° to 25°, curve near the borders, following them in anastomosing in a simple or double series of areoles; the lowest pair being thin and marginal.

It is related to the following species, from which it is, however, distinct by the form of the leaves and the nervation. It has also a marked degree of affinity to *R. œningensis* Al. Br., as it is represented in Heer's Fl. Tert. Helv. (vol. 3, p. 78, Pl. CXXIII, Fig. 31), at least by the form of the inequilateral leaves and the acute divergence of the secondaries, which, however, are more ramose in the Cretaceous species. Its relation to *Ficus primordi-*

alis Heer (Phyll. Crét. du Nébr., p. 16, Pl. III, Fig. 1), may be mentioned, although it is rather distant.

Habitat: Ellsworth County, Kansas. Nos. 489, 502 and 580 of the collection of the museum of the University of Kansas. Collected by E. P. West.

RHAMNUS REVOLUTA, sp. nov.
Pl. LXV, Fig. 5.

Leaf subcoriaceous, lanceolate, enlarged above the base, rounded to the petiole; borders revolute to near the obtuse apex, entire; median nerve broad at base, gradually narrowed to the apex, where it is nearly effaced; secondaries oblique, strong, entire or rarely forking, straight in passing to the borders, camptodrome.

The leaf, which is 6^{cm} long and 1.5^{cm} broad above the base, has nine or ten pairs of secondaries, all parallel, equidistant, at an angle of divergence of 40° from the midrib, which passes to a strong, flat petiole, which is broken quite near its point of union to the leaf. This species has no distinct relation to any other species of Rhamnus, except by its nervation.

The revolute borders do not allow a satisfactory examination of its original form.

Habitat: Probably ten miles northeast of Delphos, Kansas. No. 4175, of the collection of Mr. R. D. Lacoe.

RHAMNITES APICULATUS, sp. nov.
Pl. XXXVII, Figs. 8–13.

Leaves small, coriaceous, short petioled, entire, ovate, obovate or elliptical, rounded at apex to an apiculate point; primary nerve narrow, secondaries thin, camptodrome, curving to and along the borders.

The general facies and characters of these leaves seem at first sight to be the same as in the preceding. They differ, however, in the more or less narrowly attenuated base, either acutely or broadly cuneiform, in the rounded apex, tipped by a minute point or mucro. According to the width of the cuneate base the secondaries are at a more or less acute angle of divergence, the lowest pairs branching and anastomosing in areoles along the borders, the upper more open, shorter and parallel. The size of the leaves varies little, being from 3^{cm} to 4^{cm} in length, and from 17^{mm} to 25^{mm} in width, measured either above or below the middle; some of the leaves are obovate, as in Fig. 10; others nearly regularly oval, as in Fig. 12; others still more enlarged above the base and ovate, as in Figs. 8 and 13.

The relation of these leaves is remarkably well marked with those of *Rhamnus colubrinoides* Ett. (Tert. Fl. v. Häring, p. 75, Pl. XXV, Figs. 3–5), better represented in Heer's Fl. Tert. Helv., vol. 3, p. 78, Pl. CXXIII, Figs. 24–26, in leaves of various sizes with a nervation of the same type.

Habitat: Ellsworth County, Kansas. Nos. 437, 439, 534, 536, 796, and 799 of the museum of the University of Kansas. Collected by E. P. West.

Order CELASTRINEÆ.

CELASTROPHYLLUM DECURRENS, sp. nov.

Pl. XXXVI, Fig. 1.

Leaves subcoriaceous, large, lanceolate, gradually tapering upward (point broken), narrowed and decurring along the petiole, serrulate, median nerve strong; secondaries very close, oblique, craspedodrome.

The leaf is 11^{cm} long and 4^{cm} broad above the base, where it is enlarged, minutely serrate, the borders being notched with short equal teeth turned upward, a mode of division which is very rare in leaves from the Dakota Group. From below its broadest part it is narrowed and entire to the base and decurrent, forming a narrow rim along the petiole, which is 2^{cm} long. In the upper part it tapers to the apparently acuminate apex. The secondaries are very close and very thin, 2^{mm} distant, crossed by thin nervilles, and forming a loose, square, or quadrangular areolation resembling that of some Cenomanian species of Ficus, especially *F. atavina* Heer (Fl. Foss. Arct., vol. 3, pt. 2, Pl. XXX, Figs. 3, 3b; vol. 6, Abth. 2, p. 69).

By its form, size, and serrate borders the species much resembles *C. lanceolatum* Ett.,[1] a fragment, of which both the lower and upper part are destroyed and which has the borders more distantly serrate, the secondaries twice as distant, though at the same angle of divergence of 40°, and the same type of areolation; the median nerve, however, is much thicker. Another fragment figured in Saporta and Marion[2] is referred to the same species. It shows the teeth still larger than in Ettingshausen's figure, a far different areolation, and a thick, short petiole slightly winged. That the fragments from Gelinden may represent a different species from that from Niederschoena, as the authors suppose, does not concern my present

[1] Kreideflora v. Niederschoena, p. 260, Pl. III, Fig. 9.

[2] Vég. Marnes Heers. Gelinden, Pl. XII, Figs. 1, 2; and Révis. Fl. Heers. Gelinden, Pl. XIV, Fig. 2; *C. Benedeni*, Sap. & Mar.

researches; certainly the leaf from Kansas, which is well preserved except the apex, is another species related merely by the areolation, the texture of the leaves, and the character of the serrate borders to the leaf from Niederschoena, the teeth of which are, however, larger and more distant.

Habitat: Ellsworth County, Kansas. No. 97 of the museum of the University of Kansas; A. Wellington, collector.

CELASTROPHYLLUM? ENSIFOLIUM Lesq.

Cret. Fl., p. 108, Pl. XXI, Figs. 2, 3.

CELASTROPHYLLUM CRETACEUM, sp. nov.

Pl. XXXVIII, Figs. 12–14.

Leaves small, thickish, entire, elliptical or oblong, obtuse, gradually narrowed to the base; primary nerve strong, percurrent; secondaries very thin, mostly obsolete, distant, parallel, very oblique, camptodrome.

A number of leaves, all of small size, but of the same character, are found preserved in nodules of the Dakota Group. They are somewhat thick or of subcoriaceous texture, with borders reflexed, entire, varying in size from 2^{cm} to 4^{cm} in length and from 9^{mm} to 12^{mm} in width, the secondaries being distant, parallel, slightly curved, diverging at an angle of 30° to 35°.

In form and size these leaves resemble those of fossil species of Celastrus, Andromeda, or Calistemophyllum, described by authors. On account of their likeness to the leaves of different living genera, and the indefiniteness of their nervation, they remain of uncertain relation.

Habitat: Ellsworth County, Kansas. Nos. 643, 699, and 703 of the museum of the University of Kansas. Collected by E. P. West.

CELASTROPHYLLUM OBLIQUUM, sp. nov.[1]

Pl. LVII, Fig. 5.

Leaf small, coriaceous, apparently narrow from the round apex to the base; midrib narrow, somewhat curved; secondaries very oblique, the lowest apparently basilar, ascending parallel to the borders, anastomosing with those above by short branches at right angles.

The leaf is partly obscured by the embedding stone and its borders are not distinctly seen. The fragment preserved is 4^{cm} long and 1.5^{cm} broad

[1] This species was named "*Celastrophyllum obovatum*, sp. nov.", by Prof. Lesquereux, but this specific name is preoccupied by the *Celastrophyllum obovatum* of Fontaine (Younger Mesoz. Fl Va., pp. 307, 330, Pl. CLXXII, Figs. 9, 10), and I have therefore changed it to *Celastrophyllum obliquum*.—F. H. K.

in the upper part, being broken near the base and partly covered near the rounded apex. It has six pairs of secondaries at a very acute angle of divergence (10° to 15°), either straight or slightly curved in ascending, camptodrome, some of the secondaries being connected by a short branch transversely anastomosing as seen in the secondary nervation of *Celastrus Pyrrhæ* Ett.,[1] the only leaf to which I am able to compare the Cretaceous leaf.

Habitat: Near Fort Harker, Kansas. No. 2811 of the U. S. National Museum.

CELASTROPHYLLUM MYRSINOIDES, sp. nov.
Pl. LVII, Figs. 8, 9.

Leaves subcoriaceous, lanceolate, entire or obtusely serrulate near the apex, narrowed to the base and decurring to a short enlarged petiole; secondaries numerous, camptodrome, parallel, at an acute angle of divergence.

These leaves vary from 4^{cm} to 6^{cm} in length, 1^{cm} to 1.5^{cm} broad in the widest part above the middle, have seven to eight pairs of secondaries, the lowest diverging from the midrib at an angle of 25° to 30°, the upper gradually less oblique; the surface is somewhat undulate by the impression of the secondaries, but the borders are apparently entire.

In general form and nervation the leaves are closely related to those figured and described by Heer as *Myrsine salicoides* Al. Br., in his Fl. Tert. Helv. (vol. 3, p. 17, Pl. CIII, Figs. 16–16b), but differ in the entire borders, and in having a broader, shorter petiole bordered by the base of the decurrent leaves. Of the two leaves communicated by Prof. Al. Braun, as species of Myrica, Heer remarks that the distribution of the secondaries prevents their reference to the genus. They have, indeed, by all their characters a more marked degree of relation with some species of Celastrus, such as *C. Acherontis* Ett.,[2] described by Heer (loc. cit.), Pl. CXXI, Figs. 51, 52. The Dakota Group leaves are most like those figured in the Bilin Flora.

Habitat: Kansas.

CELASTROPHYLLUM CRASSIPES, sp. nov.
Pl. LVII, Figs. 6, 7.

Leaves small, broadly oval or suborbicular, entire, short petioled; midrib stout; secondaries parallel, curved and camptodrome.

Two leaves of this species, one 4^{cm} the other 2.5^{cm} in size both ways,

[1] Flora v. Bilin, pt. 3, p. 33, Pl. XLVIII, Fig. 21.

[2] Ibid., Fig. 9.

have a short, thick petiole 1^{cm} long, enlarged at the point of attachment. The secondaries, of which there are four or five pairs, are parallel, equidistant, and curve regularly from their point of attachment to the midrib and follow the borders, either simple or branching; the nervilles and the areolation are obsolete.

In form the leaves are comparable to those of *Celastrus minutulus* Al. Br., as figured in Heer's Fl. Tert. Helv. vol. 3, Pl. cxxi, Fig. 42, but they are much larger; the nervation is that of *C. Bruckmanni* Al. Br., in Heer (loc. cit.), Pl. cxxi, Fig. 27. The form and size of the leaf are about the same as those of *Myrsine antiqua* Ung. (Syll., pt. 3, Pl. vii, Fig. 7).

Habitat: Kansas.

ELÆODENDRON SPECIOSUM, sp. nov.
Pl. XXXVI, Figs. 2, 3.

Leaves coriaceous, rigid, linear-oblong, attenuated at the base, obtusely dentate or regularly undulate repand on the borders, entire toward the base; primary nerve thick; secondaries inequidistant, obliquely diverging from the median nerve, forking at or above the middle and again nearer to the borders, flexuous, craspedodrome, with their divisions sometimes linked at their ends.

There are three fragments of these leaves with the same characters. The leaves are thick, the surface rugulose by a small quadrate or punctiform areolation; the secondaries strongly marked, diverging at an angle of 30° to 35° from the median nerve, flexuous, diversely branching near the borders, their divisions curving in an upward or downward direction and joining the borders, which are either inflated or bordered by a marginal nerve.

The areas between the nerves are traversed lengthwise by very thin nervilles anastomosing at various angles, composing first irregular large meshes filled by very small quadrate or punctiform areoles.

The nearest relation of the species is *E. sagorianum* Ett.,[1] a Tertiary species with the teeth of the border acute, the nervation more open, the secondaries closer, equidistant, of a different character. The species from Kansas has also in its nervation a degree of affinity to *E. australe* Vent,. figured by self-impressions in Ettingshausen's Neuholl. Char. Eocenfl. Eur., p. 56, Fig. 68.

Habitat: Ellsworth County, Kansas. Nos. 55 and 56 of the collection of the museum of the University of Kansas. Collected by A. Wellington.

[1] Flora v. Sagor., pt. 2, p. 194, Pl. xvi, Figs. 16, 25.

Order ILICINEÆ.

ILEX BOREALIS Heer.

Pl. XXXV, Fig. 8.

Fl. Foss. Arct., vol. 7, p. 39, Pl. LXIV, Figs. 3, 4.

Leaves coriaceous, lanceolate, gradually narrowed to the acute base; borders entire, undulate; median nerve rigid, narrow; secondaries flexuous, dissolving in the reticulation or curving at a distance from the borders.

This leaf has all the characters of the species described by Heer with the following exception. The author says of the borders of the leaves that they are perfectly entire or denticulate. His Fig. 4 (loc. cit.) shows the borders undulate and a fragment (Fig 3) has them minutely dentate in the upper part. Fig. 4 is made like ours, from a specimen of which the upper part is destroyed; this difference, therefore, remarked upon another more fragmentary specimen can not be considered. Heer also describes the median nerve as strong, but his figure does not show it broader than it is in the leaf of the Dakota Group.

The preserved part of the leaf is 12^{cm} long, 3^{cm} broad; the secondaries, at an angle of 50° to 55° from the midrib, are parallel and about equidistant, some of them separated by shorter tertiaries, either parallel or at a more open angle of divergence. The nervilles are strong, flexuous, branching or anastomosing at right angles. The specimens figured by Heer are from Patoot, Greenland, where they occur with leaves of *Liriodendron Meekii*, *Sapindus Morrisoni*, etc.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4096 of the collection of Mr. R. D. Lacoe.

ILEX ARMATA, sp. nov.

Pl. XXIX, Fig. 8.

Leaves coriaceous, lanceolate, sharply pointed, narrowed and decurring to the base; borders nearly entire, with few acute teeth; nervation pinnate, camptodrome.

The form of this leaf is peculiar. It is narrowly lanceolate both ways, but bears on each side a single prominent tooth, one near the base which is short, blunt-pointed, at right angles to the border; the other erect, linear, acuminate, placed in the upper part, on the opposite side of the leaf; both entered by one secondary nerve which branches under them, the branches passing above along the borders. The lower pairs of secondaries are at a more acute angle of divergence than those above, which curve along the borders in simple areoles; the thin nervilles are at right angles to the nerves, flexuous and running downward. The leaf is 6.5^{cm} long, 2^{cm} broad at the middle, the base being destroyed.

Except in its nervation, which is that of the genus, the species has no nearer relative than the next.

Habitat: Ellsworth County, Kansas. No. 506 of the museum of the University of Kansas. Collected by E. P. West.

Ilex papillosa, sp. nov.

Pl. XXIX, Figs. 9, 10; Pl. LVIII, Fig. 3.

Leaves coriaceous, lanceolate, sharply acuminate, and acutely dentate on the borders; teeth turned upward, papillose at apex; secondaries very oblique, some entering the teeth, some curving in areoles near the borders; nervilles strong, at right angles to the nerves, broken at the middle by transverse veinlets forming a large, quadrangular or polygonal areolation.

The two fragments (Pl. XXIX, Figs. 9, 10) which are preserved upon the same piece of stone, represent a leaf of about the same size as that of the preceding species. The apex is formed by a sharply acuminate tooth similar to those of the borders, which are long, turned upward and marked at the acute apex by a small, round black point or knob. The secondaries, which are at an angle of divergence of 20° to 25°, are mixed, generally craspedodrome, or some of the intermediate ones camptodrome, the nervilles and areolation deeply marked.

As far as can be seen from the small fragmentary specimen (Pl. LVIII, Fig. 3), whose surface is effaced by erosion, it represents the same species. The papillæ of the teeth are scarcely marked; the leaf is of thick texture; the nervation only preserved for the secondaries, no trace of areolation remaining visible.

The species has by its nervation and the division of its borders a degree of affinity to *I. dryandræfolia* Sap.,[1] but greatly differing in the direction and in the distribution of the teeth.

Habitat: Ellsworth County, Kansas. Nos. 1000 and 1091 of the museum of the University of Kansas. Collected by E. P. West.

[1] Études, vol. 1, pt. 2, p. 89, Pl. x, Fig. 8.

ILEX DAKOTENSIS, sp. nov.
Pl. XXIX, Fig. 11.

Leaves small, coriaceous, lanceolate, tapering to the apex, narrowed to the short petiole; median nerve narrow; secondaries very thin, mostly obsolete, camptodrome.

A very small leaf, of the same form and nervation as those of *I. stenophylla* Ung., a species which is very common in the Miocene of Europe, and is figured by various authors, especially by Unger in Syll., pt. 2, p. 14, Pl. III, Figs. 15–27. The leaves of the European species are a little larger, more gradually narrowed to the petiole, obtuse or blunt pointed and not acuminate. The nervation is of the same type that is distinctly represented in Fig. 23 (loc. cit). Therefore there is no other difference in the character of the leaves than the apparently acuminate form of the Kansas leaf.

Habitat: Ellsworth County, Kansas. No. 498 of the museum of the University of Kansas. Collected by E. P. West.

ILEX STRANGULATA Lesq.

Hayden's Ann. Rept., 1874, p. 359, Pl. VII, Fig. 8; Cret. and Tert. Fl., p. 84, Pl. III, Fig. 7.

ILEX SCUDDERI, sp. nov.
Pl. LVIII, Fig. 2.

Leaves coriaceous, entire, lanceolate, polished on the surface; midrib narrow; secondaries parallel, distant, much curved and camptodrome, at a distance from the borders, which they follow in double areoles.

Only one leaf of this species has been observed as yet. It is 7^{cm} to 8^{cm} long, with the apex destroyed, 3^{cm} broad at the middle, gradually narrowed to a petiole 12^{mm} long, slightly arched to one side, with eight pairs of secondaries, the lower of which are thin, close and parallel to the borders, at a slightly more acute angle of divergence, the others thick, gradually more open; nervilles distinct, traversing the areas at various angles, and composing large primary areoles.

This species is closely related in form and nervation to *I. longifolia* Heer, as figured in Fl. Foss. Arct. (vol. 2, pt. 4, Pl. LVI, Fig. 1), differing mostly by its entire borders. The secondaries, their mode of relative position, and their large bows along the borders, are of the same character.

The leaf is also related by its nervation, its form and coriaceous texture, and its petiole, to *Bignonia capreolata* L., of the southern United States.

Habitat: Ellsworth County, Kansas. No. 810 of the collection of Prof. F. H. Snow. Collected by E. P. West.

ILEX MASONI, sp. nov.

Pl. VII, Fig. 6; Pl. LXIII, Fig. 6.

Leaf subcoriaceous, linear-oblong, slightly enlarged in the lower part, cuneiform to the base, apparently obtuse (point broken) repand-dentate on the borders; primary nerve comparatively thick; secondaries open, arched in passing toward the borders, camptodrome, anastomosing in broad, angular curves at a distance from the borders, to which they are joined by branches at right angles to the curves.

The first leaf is about 12^{cm} long, 4.5^{cm} broad below the middle, where it is slightly enlarged, is marked by a few obtuse teeth, the upper part being entire or slightly undulate. The lower pair of secondaries are thin, at a more acute angle of divergence, 50°, inequidistant, parallel, somewhat strong, distinctly camptodrome, the upper pair appearing more curved in ascending toward the apex. The bows formed by angular anastomosis of the secondaries at a short distance from the borders are linked to them by short nervilles at right angles. The surface is smooth, nearly polished, indistinctly marked by transverse nervilles. The other fragment indicates a leaf scarcely broader but much longer, broken at both ends, and cut in deeper, large teeth.

These leaves resemble those of *I. borealis* Heer,[1] but are larger, also *I. longifolia* Heer,[2] the borders of which are also minutely dentate, etc.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4105 of the collection of Mr. R. D. Lacoe. Collected by Mr. S. C. Mason, for whom the species is named.

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[1] Fl. Foss. Arct., vol. 7, p. 39, Pl. LXIV, Figs. 3, 4.

[2] Fl. Foss. Arct., vol. 1, p. 124, Pl. XLVIII, Figs. 3, 4.

Order TILIACEÆ.

Tribe APEIBEÆ.

APEIBOPSIS CYCLOPHYLLA, sp. nov.
Pl. XXV, Fig. 6.

Leaves membranous, entire, polished on the surface, nearly round, abruptly, slightly declining downward in reaching the broken petiole; median nerve strong, rigid; secondaries also strong, five pairs, alternate, equidistant, parallel, slightly curved in passing to the borders, simple, camptodrome, the lower pair supra-basilar; angle of divergence 45°, nervilles strong, at right angles, simple or sometimes curved and forking at the middle; areolation very distinct, in small quadrate meshes.

This leaf, which is 7^{cm} long and 6^{cm} broad, has the same form and about the same size and character as that of *A. Thomseniana* Heer,[1] and would be referred to this species but for one pair of thinner, basilar nerves close to the lower secondaries, ascending in a broad curve to the middle of the leaf, which, although seen in the leaf from Greenland, is not present in that of the Dakota Group. In Heer's leaf also the areolation, which in that from Kansas is very distinct and quadrate, is not figured, or is, as he says, effaced; and there is only a single leaf of this form known from Greenland and one from the Dakota Group. The points of comparison are insufficient. No traces of the fruits of Apeibopsis, which have been abundantly found in the Miocene flora of Europe, have been as yet observed in the Cretaceous. The generic relation of the leaf is therefore not positively established.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4162 of the collection of Mr. R. D. Lacoe.

Tribe GREWIEÆ.

GREWIOPSIS HAYDENII Lesq.

Cret. Fl., p. 97, Pl. III, Figs. 2, 4; Pl. XXIV, Fig. 3.

GREWIOPSIS ÆQUIDENTATA, sp. nov.
Pl. LVIII, Fig. 4.

Leaf subcoriaceous, ovate, subtruncate or broadly cuneate at the enlarged base, gradually narrowed or tapering upward, obtusely pointed, borders distinctly, acutely, simply, rarely doubly dentate; midrib strong;

[1] Fl. Foss. Arct., vol. 6, Abth. 2, p. 95, Pl. XXXVI, Fig. 5.

secondaries parallel, equidistant, oblique, nearly straight toward the borders, branching above, craspedodrome.

The leaf is about 8^{cm} long, 6.5^{cm} broad near the base, where it is cut or obliquely truncate, abruptly deflexed to the base of the midrib and decurring to it by a short inside curve. The secondaries, of which there are seven pairs, diverge from the midrib at an angle of 40° to 45°, the lower branching, the others simple, entering the teeth directly or by intermediate, shorter teeth, anastomosing at right angles with tertiary divisions, as often observed in species of Grewiopsis.

This latter is not, however, sufficient proof of the relation of the leaf to any species of Grewiopsis. It differs from all the leaves referred to this genus by the enlarged, subtruncate base, the longer, acute teeth, which are separated by a broad sinus, showing the same difference with any kind of leaves of Quercus or Viburnum to which it might be compared by the character of the nervation.

Habitat: Ellsworth County, Kansas. No. 1188 of the collection of Mr. R. D. Lacoe.

GREWIOPSIS MUDGEI, sp. nov.

Pl. LXVI, Fig. 3.

Leaf thickish, subcoriaceous, ovate, obliquely truncate at the base, dentate; median nerve rigid; secondaries oblique, equidistant, and parallel, simple or with few thin branches obliquely passing to the veinlets, joining the border at right angles, lowest pair supra-basilar.

The leaf is 7^{cm} to 8^{cm} long (apex destroyed), 6.5^{cm} broad near the base, and has seven pairs of secondaries, the lowest supra-basilar, diverging 50° from the midrib, joined by strong nervilles at right angles, simple or forking, some of them entering the teeth by deviating at right angles from the point of connection or forking of the oblique nervilles. The border teeth are very distinct, pointed and turnede outside or at right angles to the borders, separated by broad sinuses; the basil borders are obliquely turned upward from the base of the midrib.

I do not find any point of comparison for this peculiar leaf except in the large leaves of *G. anisomera* Sap. (Fl. Foss. Sézanne, p. 409, Pl. XIII, Fig. 8), and this even only in the character of the nervation and the peculiar distribution of the nervilles near the borders. *G. credneriæformis* Sap. (Fig. 7), of the same plate, has also a degree of affinity by the direction and position of the secondaries, the lower pair of which, however, in both species are not so supra-basilar.

Habitat: Ellsworth County, Kansas. No. 1188 of the collection of Mr. R. D. Lacoe.

Order STERCULIACEÆ.

Tribe STERCULIEÆ.

STERCULIA MUCRONATA, sp. nov.
Pl. XXX, Figs. 1–4.

Leaves small, subcoriaceous, narrowed, subcordate or truncate at base, three to five palmately lobed, three palmately nerved from the top of the petiole; lobes entire, lanceolate or narrowed in rounding to a linear obtuse mucro; primary lateral nerves simple or forking near the base; secondaries curved upward, camptodrome.

The largest of these leaves (Fig. 1) is more than 10^{cm} broad between the apices of the lateral lobes, and is 6^{cm} long from the top of the petiole to the apex of the median nerve. The lobes diverge 30° to 40°, and like the primary nerves with their divisions, are entire, either rounded above and narrowed to the mucronate apex or lanceolate and tapering upward. The sinuses are broad, the petiole long. The different forms of the leaves are seen in the four figures of the species, Figs. 3 and 4 being merely trilobate, the one rounded toward the apex, the other gradually acuminate.

The species is especially related by the form and disposition of the lobes to *Liquidambar integrifolium* Lesq. (Cret. Fl., p. 56, Pl. II, Figs. 1–3; Pl. XXIV, Fig. 2; Pl. XXIX, Fig. 8). But for the prolongation of the apex into a linear point, these leaves might be referred to this last species, for in Cret. Fl., Pl. XXIV, Fig. 2, the camptodrome nervation is of the same type, and the lobes, which are obtuse in Fig. 2, are also sometimes lanceolate and blunt pointed as in op. cit. (Pl. II, Figs. 2, 3). This indicates for the leaves of Sterculia the same disposition to variability in the Cretaceous as is observed in the species of the Miocene and of the present epoch. *S. carthaginensis* Cav. of the living flora has leaves of analogous characters to those of the species described above.

Habitat: Ellsworth County, Kansas. Nos. 731, 735, 736, and 741 of the museum of the University of Kansas; E. P. West, collector.

STERCULIA SNOWII, sp. nov.

Pl. XXX, Fig. 5; Pl. XXXI, Figs. 2, 3; Pl. XXXII, Pl. XXXIII, Figs. 1-4.

Leaves long petioled, membranous or subcoriaceous, large, palmately two to five lobed; lobes entire, lanceolate, taper pointed or acuminate, greatly diverging; primary nerves palmately three to five, from the top of the petiole, mostly simple, thick, percurrent; secondaries thin, oblique, straight or slightly curved in traversing the blade, simply camptodrome.

The largest leaves are more than 20^{cm} long from the top of the petiole to the apex of the median lobe, and are quite as broad or broader between the apices of the lateral lobes; the petiole generally preserved is more than 20^{cm} long, strong, inflated at the base. The divergence of the lobes averages 40°, the lateral ones being about at right angles to the median nerve, and generally curved backward; the primary nerves are thick, the secondaries thin, often obsolete, close, parallel, at an angle of divergence of 50°, curving quite near the borders, the curves forming a kind of thin, marginal nerve along them; the areolation is obsolete.

These fine leaves, largely represented in the collection, vary in form according to the distribution of the primary nerves and the divergence of the lobes. Pl. XXXI, Fig. 2, representing one of the best preserved leaves, shows the general mode of divisions of the lobes and the nervation as far as it can be seen; its petiole is as long as that of the specimen (Pl. XXXIII, Fig. 1). The leaf (Fig. 2) of the same plate is merely trilobate but its divisions have the same character, while the one shown in Fig. 3 is quadrilobate by subdivision of the lateral lobes on one side only. Pl. XXX, Fig. 5, shows a leaf five-lobate by the same kind of division of both lateral lobes, and Pl. XXXIII, Fig. 4, an abnormally bilobate one, one of the thin lateral nerves not being strong enough for the production of a lobe and passing toward the border as merely camptodrome.

This fine species is evidently related to the preceding one, from which it differs in its large size, the form of the lobes, and the nervation. Comparing the character of these leaves with those of some Tertiary species, an affinity of nervation is recognized with *Liquidambar europæum miocenum* Sap. & Mar. (Vég. Foss. Meximieux, Pl. xxv, Fig. 4), and for the shape of the leaves and the disposition of the lobes with *Platanus Sirii* Ung.,[1] a peculiar five-lobed leaf which Schimper identifies with *Sterculia Labrusca* Ung. Taken all together this new species is indeed related to some varieties of *S. Labrusca*, the leaves of which are figured as being five-lobed (Engelhardt,

[1] Flora v. Sotzka, p. 166, Pl. XXXVI, Fig. 1.

Tertiärfl. v. Göhren, p. 29, Pl. XIII, Fig. 1), and *S. Majolana* Mass. (Massalongo Fl. Foss. Senigall., Pl. XX, Fig. 3), the nervation of these Tertiary leaves being, however, different. The leaf shown in Pl. XXXII, Fig. 1, is deformed in a peculiar way. Its median lobe is shorter, rounded at apex, and its secondaries are more distant and ramose.[1]

The leaf Pl. XXXI, Fig. 2, is partly covered by very distinct round or oval, even sometimes triangular dots, $\frac{1}{2}^{mm}$ to 1^{mm} in diameter, a species of Sphæria[2] with two marginal prominent rings surrounding a small, central areole (Fig. 2a, enlarged). It greatly resembles *S. Braunii* Heer (Fl. Tert. Helv., vol. 1, p. 14, Pl. I, Figs. 2–2c, e). Though the species can not be identified, the generic reference is evident.

Habitat: Ellsworth County, Kansas. Nos. 30a, 30g, 734, 742, etc., of the museum of the University of Kansas; A. Wellington and E. P. West, collectors.

STERCULIA SNOWII var. DISJUNCTA, n. var.

Pl. LVIII, Fig. 6.

Leaf doubled by a division of the midrib from its base and in a vertical direction into two bilobate leaves, each with two strong lateral nerves, forking above the base and diverging, representing two lobate leaves with long, lanceolate, acuminate lobes, separated by broad sinuses joined at the base to the principal or median nerve which forms a short petiole for each of the leaves. The secondaries, a few of which are observable upon the leaf of the right side, are thin, parallel, oblique.

Each part of the leaf of this remarkable fossil really represents a single leaf cut, or parted, in two at the top of the midrib.

This leaf is referable to *S. Snowii* (Pls. XXXII, XXXIII) as a mere deformation or monstrosity of the species. The other (Fig. 2) is a deformation of a different kind, in which a leaf of the same species shows on one side the lobe in its natural form and position, while on the other the lateral lobe is rounded and curved to the median nerve. The examination of a number of specimens of this species gives the means of referring to the normal form a number of those peculiar variations.

Habitat: Near Fort Harker, Kansas. No. 2745 of the U. S. National Museum.

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[1] "*Sterculia Snowii* is of the same type as *S. limbata* Velen. (Fl. böhm. Kreide. pt. 2, Pl. V, Figs. 2–5; Pl. VI, Fig. 1)." Note by Prof. Lesquereux a short time before his death.—F. H. K.

[2] This species has been named *Sphæria problematica* Knowlton. See *ante*, p. 23.

Sterculia aperta Lesq.

Pl. XXII, Fig. 4.

Cret. and Tert. Fl., p. 82, Pl. x, Figs. 2, 3.

Leaves subcoriaceous, palmately trilobed, and triplenerved from the base; lobes lanceolate, blunt at apex; angle of divergence broad.

The leaf figured here differs from those in Cret. and Tert. Fl. (loc. cit.) by the broader size of the lobes, which are more openly divergent with narrower sinuses. The secondary nervation is obsolete. It has by its broader lobes a degree of affinity to *Aralia grœnlandica* Heer,[1] which has, however, the lobes broader, the lateral ones being sometimes cut into one or two short obtuse lobes on the lower side. The leaf from Kansas is like an intermediate form between those figured in Cret. and Tert. Fl. (Pl. x, Figs. 2, 3) and those of *A. grœnlandica* figured by Heer.

Habitat: Ellsworth County, Kansas. No. 8 of the museum of the University of Kansas. Collected by A. Wellington.

Sterculia obtusiloba Lesq.

Cret. and Tert. Fl., p. 82, Pl. viii, Fig. 3.

Though this form appears far different from the preceding one, it may be a mere variety of the same species.

Habitat: Near Fort Harker, Kansas.

Sterculia reticulata, sp. nov.

Pl. XXXIV, Fig. 10.

Leaves small, rigid, coriaceous, palmately trilobed from below the middle, trinerved from above the basil border, entire, long-petioled; lobes half open, linear, obtuse, the middle longer; primary nerves thick, equal, distinctly percurrent; secondaries oblique, parallel, close and equidistant, strong, camptodrome; nervilles deep, at right angles, forming by subdivisions a coarse, irregulary quadrate, or polygonal reticulation.

The leaf, which is 7^{cm} long, including the petiole, which is itself 1.5^{cm} long, is fully preserved. It is inflated at the base, cuneiform, joining the petiole at the same angle of divergence as the lateral primary nerves (40°), and a little decurrent at the base. The median nerve is 27^{mm} long above the sinuses, the lateral ones only 20^{mm}.

The leaf has for its nearest relative *S. diversifolia* G. A., as represented

[1] Fl. Foss. Arct., vol. 6, Abth. 2, p. 84, Pl. xxxviii, Fig. 3.

in Ettingshausen Neuholl. Char. d. Eocenefl. Europa's, p. 57. I have not seen in fossil leaves any one of analogous characters.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4015 of the collection of Mr. R. D. Lacoe.

STERCULIA LUGUBRIS Lesq.

Cret. and Tert. Fl., p. 81, Pl. VI, Figs. 1–3.

Tribe HELICTEREÆ.

PTEROSPERMITES MODESTUS, sp. nov.

Pl. LVIII, Fig. 5.

Leaf small, subcoriaceous, oval, rounded at base to the enlarged midrib and in the same degree to the obtuse apex, entire; secondaries four pairs, three lowest close to each other, opposite, the upper a single pair far distant from the lower ones, all open in joining the midrib, then curved upward toward the borders, craspedodrome.

The leaf is only 5^{cm} long from its base, more than 4^{cm} broad at the middle, and has a short petiole, apparently broken, 3^{mm} below the base of the leaf. The secondaries are distributed. three at a short distance from each other in the lower part of the leaf, one only at a distance above, and curve toward the midrib, which they reach at an open angle of divergence, traversing the blade in ascending toward the borders, and craspedodrome; the upper ones have few branches, while the lower are joined by nervilles at right angles, the middle space being taken by thin, flexuous nervilles at right angles to the midrib.

This leaf has an evident likeness in form, size, and nervation to *Pterospermum sagorianum* Ett. (Foss. Fl. v. Sagor, pt. 2, p. 187, Pl. XV, Fig. 17).

Habitat: Near Fort Harker, Kansas. No. 2813 of the U. S. National Museum.

PTEROSPERMITES LONGEACUMINATUS, sp. nov.

Pl. LIX, Fig. 3.

Leaves ovate-lanceolate, prolonged into a very long, narrow acumen; borders entire or marked by one or two acuminate teeth; narrowed in rounding to the base and reaching the thick petiole in declining and decurring abruptly to it; midrib straight, thick in the lower part, very thin in the upper; secondaries alternate, at an acute angle of divergence, curved and declining at base in joining the midrib, camptodrome, only one passing to the apex of the single lateral tooth.

The authority for the reference of these two leaves to Pterospermites is their extraordinary likeness to a Pterospermum undetermined, and *P. suberifolium* Willd., figured on Pl. XLIX, Figs. 6, 9 of Ettingshausen's Blattskelete der Dikotyledonen. The specimen represents a whole ovate leaf, 16.5^{cm} long to the base of the long acumen (there destroyed), 7^{cm} broad below the middle, with a thick petiole 3.5^{cm} long and 2^{mm} broad. The large leaf is superposed upon a fragment of another of the same species, turned and flattened in an opposite direction, and of which the long acumen is preserved, it being at its base 1.5^{cm} broad and only 5^{mm} in diameter 4^{cm} above the base. This fragment has also a high lateral lobe, or a tooth formed by one of the secondaries passing upward to its sharply pointed apex.

Though the areolation of these leaves is comparable to species of Pterospermum, they may be compared to species of Ficus by their peculiar nervation and the prolongation of the acumen, as seen in *F. superstitiosus* L., and the beautiful *F. producta* L.

Habitat: Near Fort Harker, Kansas No. 2742 of the National Museum.

PROTOPHYLLUM LECONTEANUM Lesq.

Pl. XL, Fig. 1.

Cret. Fl., p. 103, Pl. XVII, Fig. 4; Pl. XXVI, Fig. 1; Cret. and Tert. Fl., p. 89.

Leaves coriaceous, very large, round or reniform in outline, broader than long, round peltate at base; borders entire or obscurely undulate; primary nerve thick; secondaries strong, a little curved, flexuous in passing toward the borders, ramose; nervilles thick, at right angles, mostly simple, anastomosing with veinlets of a lower degree, composing by ramification a distinct polygonal areolation.

The largest part of a leaf of this species has been carefully figured in order to fix the characters of the species vaguely indicated by the fragment in Cret. Fl. (loc. cit.).

By a study of this leaf the differences between *P. Leconteanum* and *P. Sternbergii* are clearly brought out. The leaves of the first of these species differ at first by their very thick texture; then they are not acute at apex but rounded, and the upper part of the pedicel, which appears to be very long, is covered by a large pelta, traversed by strong secondary nerves, diverging around from the base of the midrib. In *P. Sternbergii* the secondaries are less ramose, the branches being mostly simple, while in *P. Leconteanum* they are often divided into tertiaries and quaternaries. The greatest difference, however, may be seen in the size of the pelta. A number of specimens of *P. Sternbergii* more recently received, one of which is figured (Pl. XLII, Fig. 1), have a narrow pelta, or rather a basal border, entered by one or two basilar nerves which emerge at right angles from the base of the midrib, but do not diverge downward into it. In *P. Leconteanum* as in *P. præstans* the pelta is an enlarged part of the leaf analogous to the stipular appendages which remain attached to the base of the leaves of some species of Platanus, as *P. basilobata* Ward, of the Laramie.

Habitat: Ellsworth County, Kansas. No. 784 of the museum of the University of Kansas; E. P. West, collector.

PROTOPHYLLUM PRÆSTANS, sp. nov.

Pl. XLI, Figs. 2, 3; Pl. XLII, Figs. 3, 4.

Leaves large, membranous, long petioled, ovate, obtusely pointed, rounded at base into a broad peltate auricle covering the top of the petiole, dentate on the borders except at the base of the auricle; nervation irregularly palmately trifid; primary basilar nerves open, nearly at right angles, alternate; lower primaries, three pairs, curved downward into the auricle, branching and anastomosing near the borders, craspedodrome in their division; secondaries, seven or eight pairs, oblique, alternate or opposite, all forking one to three times from above the middle; divisions craspedodrome; nervilles strong, at right angles to the nerves, distant, rarely simple, mostly forking at the middle.

This fine species differs from its congener first by its somewhat thin but hard, solid membranous texture, which renders its surface apparently rough. Of the four leaves figured, the largest, fully developed, is 20^{cm} long, including the basilar, round pelta, and 15^{cm} broad at the middle. The smaller leaf, which is preserved entire (Pl. XLII, Fig. 3), appears broadly, angularly pointed, and from Pl. XLI, Fig. 3, the auricle, which in Fig. 2 is partly lacerated, is seen to be rounded and traversed from its margin around the petiole to the borders by three pairs of primary basilar nerves curving downward. Its petiole is preserved entire and is 5^{cm} long and slightly inflated at its point of attachment. Fig. 4 of Pl. XLII is a fragment of a very small leaf having the character of the species especially distinct in its texture, the lower secondaries being arched downward. Pl. XLI, Fig. 3, has the borders reflexed or immersed in the stone, and the secondaries, therefore, are not seen in their whole length.

Habitat: Ellsworth County, Kansas. Nos. 23b, 23c, 50, 51, etc., of the museum of the University of Kansas. Collected by A. Wellington.

PROTOPHYLLUM STERNBERGII Lesq.
Pl. XLII, Fig. 1.

Cret. Fl., p. 101, Pl. XVI; Pl. XVIII, Fig. 2; Cret. and Tert. Fl., p. 89.

The specimen here figured shows very clearly the characters of the species.

The leaves are ovate, obtusely pointed, truncate at the base, which covers by a narrow border the upper part of the petiole, and the basilar primaries are in two pairs, the upper at right angles, the other pair diverging downward into the prolonged base of the leaves. Contrary to the general distribution of the secondaries, those of this species are at an acute angle of 40°, and are alternate from the base of the leaf.

Habitat: Ellsworth County, Kansas. No. 22 of the museum of the University of Kansas; A. Wellington, collector.

PROTOPHYLLUM UNDULATUM, sp. nov.
Pl. XLII, Fig. 2.

Leaf large, coriaceous, round-ovate, narrowed to the apex (broken), rounded at base, distinctly and regularly undulate or obtusely dentate; secondaries basilar, three or four pairs, derived from the base of the midrib, the upper at right angles, the lower curving downward into the prolonged base of the leaf; secondaries, five to six pairs, the lower opposite, all parallel and equidistant, at an angle of divergence of 45° to 50°.

This form or species is in its characters intermediate between *P. Sternbergii* Lesq. and *P. quadratum* Lesq. (Cret. Fl., p. 104, Pl. XIX, Fig. 1). The leaf is broader than that of the first-named species and has its base more prolonged, has a larger number of basilar nerves, the lower secondaries being opposite and the borders evidently regularly undulate-dentate. From the second it differs still more by the broader base of the leaves, the median nerve being narrower, though the leaf is larger, the secondaries somewhat curved, and the borders dentate. It may, however, represent a variety of this last species.

Habitat: Ellsworth County, Kansas. No. 50 of the collection of the museum of the University of Kansas. Collected by A. Wellington.

PROTOPHYLLUM CRENATUM.[1]

Pl. LXV, Fig. 7.

Leaf small, nearly round or ovate (upper part destroyed), 4^{cm} long, 7^{cm} broad, apparently of thin texture, obscurely undulate-dentate on the borders, round peltate, the strong median nerve passing under the border 1.5^{cm} above the base; basilar lower pair of secondaries horizontal, the four pairs above opposite, curving in traversing the lamina, more or less branching.

The pelta or border base is not auricled, or like a continuation of the border, but is traversed downward by four smaller nerves from the base of the median nerve, and curving along the borders. There are two specimens of the small leaves which by their characters appear identical with *P. undulatum* as figured (Pl. XLII, Fig. 2), but far different in the size of the leaves and their texture.

Habitat: Ellsworth County, Kansas. No. 557 of the collection of Mr. R. D. Lacoe.

PROTOPHYLLUM DIMORPHUM, sp. nov.

Pl. XLI, Fig. 1.

Leaf small, coriaceous, rigid, round-quadrangular in outline, truncate, enlarged, obtusely lobed at apex, cordate and entire at base, undulate-dentate on the borders, petioled; nervation very thick, craspedodrome; basilar primaries three pairs, the upper at right angles, simple on one side, branching on the other, the middle attached to the base of the upper, curving downward, the lower very thin, close to the borders or marginal; secondaries three to four pairs, the lower opposite and branching, the upper with few branches and alternate; nervilles strong, forked at the middle or anastomosing by oblique branches.

This fine small leaf is remarkable for the abnormal disposition of its nerves and the unequal width of the lamina, being more expanded, as seen by the figure, on the right side of the median nerve. Owing to this the lateral nerves are longer and more branching on the right side than on the left. The secondaries pass to the point of the short teeth or undulations of the borders, which by contraction at their extremities and declining on both sides become thus slightly emarginate. The leaf seems to have

[1] This species was marked "*Protophyllum undulatum* or n. sp." in the manuscript by Prof. Lesquereux. As it seems from the appearance of the leaves and by the description to differ from *P. undulatum*, I have thought best to regard it as a new species, and have named it *Protophyllum crenatum*.—F. H. K.

been preserved in its full development. It is nearly 4^{cm} long and as broad, with a petiole 1.5^{cm} long, much enlarged to the base.

Habitat: Ellsworth County, Kansas No. 53 of the museum of the University of Kansas; A. Wellington, collector.

Protophyllum multinerve Lesq.

Pl. XLIII, Fig. 2; Pl. LXV, Fig. 1.

Cret. Fl., p. 105, Pl. XVIII, Fig. 1; Cret. and Tert. Fl., p. 89.
Pterospermites multinervis Lesq., Hayden's Ann. Rept., 1871, p. 302.

Leaves coriaceous, oblong-ovate, round, truncate at base, peltate; primary nerves strong; secondaries close, parallel, numerous; borders undulate or obtusely dentate.

The leaf figured on Pl. XLIII (Fig. 3), which is well preserved, shows the characters of the species better than any before obtained. Though somewhat smaller, it has nearly the same number of secondaries as that figured in Cret. Fl. (loc. cit.), that is, twelve pairs, besides two pairs in the pelta, passing downward and curving at the borders.

The other shown on Pl. LXV (Fig. 1) is a splendid leaf preserved nearly entire, round in outline, 11^{cm} long, 10^{cm} broad, borders nearly entire, traversed by the petiole 1.5^{cm} above the base, which is rounded but not distinctly peltate. The basal border, however, is filled by the lowest secondaries curved downward and branching, as in my figure of *P. multinerve* (Cret. Fl., Pl. XVIII, Fig. 1), and the nervation, number of secondaries, branches, etc., are alike in both leaves, this one differing essentially by the borders being mostly entire or denticulate by the slight projections of the end of the secondaries and of their branches. Admitting this specimen as *P. multinerve*, that figured on Pl. XLIII, Fig. 2, appears different, as it is coarsely dentate on the borders; but this dentation may be caused by erosion of the borders. The specimen now under consideration is a smaller leaf differing by the secondaries being more distant, less numerous, and more open.

Habitat: Ellsworth County, Kansas. No. 111 of the museum of the University of Kansas (Pl. XLIII, Fig. 2). Collected by A. Wellington. No. 827 of the collection of Mr. R. D. Lacoe (Pl. LXVII, Fig. 1).

PROTOPHYLLUM HAYDENII Lesq.
Pl. XLIII, Fig. 1; Pl. XLIV, Figs. 1, 2.

Cret. Fl., p. 106, Pl. XVII, Fig. 3; Cret. and Tert. Fl., p. 90.
Pterospermites Haydenii Lesq., Hayden's Ann. Rept., 1871, p. 302.

Leaves coriaceous, variable in size, long petioled, broadly ovate in outline, truncate at base, obtuse at apex, mostly entire or sometimes regularly, deeply undulate or obtusely dentate, not peltate; nervation strong, deeply impressed, craspedodrome; lowest secondaries, of which there are two or three pairs, thinner, nearly at right angles to the median nerve, less distant than the others, nearly simple; those above parallel, equidistant, nine to twelve pairs according to the size of the leaves, gradually more oblique upward, the lower branching underneath, the upper simple or forking near the borders.

The leaves vary from 5^{cm} to 16^{cm} in length, being generally as broad at the middle as long. The petiole is from 3^{cm} to 8^{cm} long, not broader than the base of the midrib; the teeth of the borders are each entered by the ends of the secondaries or of their branches; the surface is a little rugose and traversed at right angles to the secondaries by deep, thin, simple, or forking undulate or curved nervilles, whose subdivisions into areoles are not perceivable; the surface appears rather punctulate than reticulate.

This species differs from those described above by the absence of a peltate or basilar border covering the upper part of the petiole. In this the leaves resemble those of Credneria, from which they differ by the straight, craspedodrome nervation. The affinity of these leaves to those of *P. Sternbergii* Lesq., or more especially to those of *P. multinerve* Lesq., is so distinct that they can not be placed in a different genus merely from the absence of a peltate base. It is, however, advisable to have the species of Protophyllum separated into two groups, those with a peltate base, the others without it; these more evidently related to Credneria.

Habitat: Ellsworth County, Kansas. Nos. 84, 110, 116, and 187 of the museum of the University of Kansas; A. Wellington and E. P. West, collectors.

PROTOPHYLLUM INTEGERRIMUM Lesq., sp. (ined).
Pl. XLIII, Fig. 3.

Prof. N. H. Winchell, Report of the Geological State Survey of Minnesota (inedited).

Leaves coriaceous, thick, the surface polished, round or broadly elliptical in outline, rounded at the base and the apex, petioled, obscurely palmately nerved. Lower lateral nerves of two pairs, nearly at right angles, the upper forked, the lowest simple, both curved backward; lateral primaries and secondaries at the same angle of divergence (35° to 40°), parallel, and equidistant; the secondaries, four pairs, strong, opposite, branching on the lower side, craspedodrome with their divisions; nervilles at right angles to the nerves, distinct.

This fine species, with the characters of the genus distinctly marked in the nervation, is remarkable for the entire borders and the smooth surface of the leaves. The secondaries are all opposite, a character more or less distinctly seen in the leaves of most of the species of Protophyllum, especially in the upper secondaries.

Habitat: Mankato, Minnesota. Communicated by Prof. N. H. Winchell.

PROTOPHYLLUM DENTICULATUM, sp. nov.

Pl. XXXVI, Fig. 9.

Leaf coriaceous, round or reniform, enlarged on the sides, truncate at the base, minutely but sharply denticulate all around except at the base, petioled; median nerve thick, percurrent; lateral primaries supra-basilar, very open, the upper branched outside, the lower simple, thin, at right angles to the midrib; secondaries, four pairs, subopposite, more or less branching, craspedodrome with their divisions; nervilles at right angles to the secondaries, distinct, simple or forked; areolation small, quadrate, prominent.

The leaf measures transversely 7^{cm}, vertically 5.5^{cm}. The borders are marked by sharp, minute teeth turned outside and entered by the lateral nerves and their divisions, which are all craspedodrome; the base is truncate, entire.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4184 of the collection of Mr. R. D. Lacoe.

PROTOPHYLLUM CRASSUM, sp. nov.

Pl. LXV, Fig. 4.

Leaves small, round or oval, entire; median nerve thick, passing under the border of the truncate base; lowest pair of secondaries much branched, with one or two pairs of thinner, horizontal ones underneath, these simple or branching. Secondaries equidistant, parallel, very thick, craspedodrome, the inferior branching, the upper only simple; nervilles very thick and close, at right angles to the secondaries, parallel, simple, rarely forking.

There are two specimens of this remarkable species; the best preserved is smaller, nearly round, 3^{cm} in diameter, the midrib passing under the basal border, scarcely 2^{mm} above the truncate base. The secondaries are of seven pairs, the lowest, which are at right angles to the midrib, are thick and rigid, forming with the transverse, thick, parallel nervilles a very rough surface. These may be young, not fully developed leaves of *P. rugosum* Lesq.

Habitat: Ellsworth County, Kansas. No. 1171 of the collection of Mr. R. D. Lacoe.

PROTOPHYLLUM CREDNERIOIDES Lesq.

Pl. XXXVI, Fig. 11; Pl. XLIII, Figs. 4, 5.

Hayden's Ann. Rept., 1874, p. 363, Pl. III, Fig. 1; Pl. VIII, Fig. 4; Lesquereux, Cret. and Tert. Fl., p. 90, Pl. II, Figs. 1–3.

As may be seen in comparing the leaves referred to this species, they are very variable in size and also in the characters of nervation, being nearly entire or undulate on the borders, round or obtuse at the apex, with distant primary nerves and a thin basilar nerve underneath or with all the lateral nerves alternate, parallel, simple, or branching, distributed like secondaries. From this it may be reasonable to conclude that some of the numerous forms described above as species may ultimately be recognized as mere varieties when it is possible to compare a larger number of specimens.

Habitat: Ellsworth County, Kansas. No. 866 of the museum of the University of Kansas; E. P. West, collector.

PROTOPHYLLUM PSEUDOSPERMOIDES, sp. nov.

Pl. LIX, Fig. 2.

Leaves small, coriaceous, ovate, obtuse, truncate at base, sharply dentate on the borders; primary nerve narrow, prolonged to a short petiole; middle pair of secondaries at a distance from the borders, oblique, with lower pairs of secondaries nearly at right angles to the midrib, arched downward, simple, and five upper pairs, oblique and parallel to the middle; all more or less branching, craspedodrome; teeth short but acute, with shallow sinuses.

Habitat: Kansas

PROTOPHYLLUM PTEROSPERMIFOLIUM, sp. nov.
Pl. LIX, Fig. 1.

Leaves, small, coriaceous, nearly round, subcordate at base, narrowed at apex, nearly entire or undulate-repand; primary nerve narrow, slightly enlarged at the point of attachment of the lower secondaries, far above the base, with two pairs of inferior ones passing at right angles from the midrib and gradually declining downward and branching; upper secondaries six pairs, gradually more oblique above the lower, branching, all craspedodrome; nervilles at right angles to the secondaries, rarely simple, mostly forking at the middle, forming by subdivisions small, quadrate areoles.

By the position of the two lower pairs of secondaries this leaf is related to some of those referred by Heer to Pterospermites. But the prolongation of the median nerve between two lower pairs of secondaries, inclining downward and craspedodrome, refers it to Protophyllum. The relation of this leaf is therefore multiple or not definite. It is comparable to *P. Haydenii* Lesq. and *P. integerrimum* Lesq., Pl. XLIII, Figs. 1–3.

Habitat: Kansas.

PROTOPHYLLUM QUADRATUM Lesq.

Cret. Fl., p. 104, Pl. XIX, Fig. 1.
***Pterospermites quadratus* Lesq., Hayden's Ann. Rept., 1871, p. 301.**

PROTOPHYLLUM RUGOSUM, Lesq.

Cret. Fl., p. 105, Pl. XVII, Figs. 1, 2; Pl. XIX, Fig. 3.
***Pterospermites rugosus* Lesq., Hayden's Ann. Rept., 1872, p. 426.**

PROTOPHYLLUM MINUS Lesq.

Cret. and Tert. Fl., p. 89, Pl. IV, Fig. 6; Cret. Fl., p. 104, Pl. XIX, Fig. 2; Pl. XXVII, Fig. 1.

PROTOPHYLLUM NEBRASCENSE Lesq.

Cret. Fl., p. 103, Pl. XXVII, Fig. 3.

PROTOPHYLLUM? MUDGEI Lesq.

Cret. Fl., p. 106, Pl. XVIII, Fig. 3.

ANISOPHYLLUM SEMIALATUM Lesq.

Cret. Fl., p. 98, Pl. VI, Figs. 1–5.
***Quercus semialata* Lesq., Am. Jour. Sci. and Arts (series 2), vol. 46, 1868, p. 96.**

Order MENISPERMACEÆ.

Tribe COCCULEÆ.

MENISPERMITES OBTUSILOBUS Lesq.

Cret. Fl., p. 94, Pl. XXV, Figs. 1, 2; Pl. XXVI, Fig. 3; Cret. and Tert. Fl., p. 78, Pl. XV, Fig. 4.

MENISPERMITES OBTUSILOBUS var. (?) Lesq.

Cret. Fl., p. 95, Pl. XXII, Fig. 1.

MENISPERMITES SALINENSIS Lesq.

Cret. Fl., p. 95, Pl. XX, Figs. 1, 4

MENISPERMITES ACUTILOBUS Lesq.

Cret. and Tert. Fl., p. 78, Pl. XIV, Fig. 2.

MENISPERMITES POPULIFOLIUS Lesq.

Hayden's Ann. Rept., 1874, p. 357, Pl. V, Fig. 3; Cret. and Tert. Fl., p. 79, Pl. IV, Fig. 4.

MENISPERMITES CYCLOPHYLLUS Lesq.

Hayden's Ann. Rept., 1874, p. 358, Pl. VI, Fig. 4; Cret. and Tert. Fl., p. 79, Pl. XV, Fig. 3.

MENISPERMITES OVALIS Lesq.

Hayden's Ann. Rept., 1874, p. 357, Pl. V, Fig. 4; Cret. and Tert. Fl., p. 80, Pl. XV, Fig. 5.

MENISPERMITES GRANDIS Lesq.

Cret. and Tert. Fl., p. 80, Pl. XV, Figs. 1, 2.

MENISPERMITES ACERIFOLIUS Lesq.

Cret. Fl., p. 96, Pl. XX, Figs. 2, 3.

MENISPERMITES RUGOSUS, sp. nov.
Pl. XXIX, Fig. 7.

Leaves comparatively small, subcoriaceous, round or reniform, truncate-subcordate at base, peltate, equally dentate all around except at the base; median nerve strong, the lateral curved and ramose, craspedodrome.

The leaf measures 6^{cm} horizontally and 5^{cm} vertically, and has the borders marked by obtuse distant teeth varying in length according to the size of the secondaries and their divisions which enter them. Only the branches of the basilar nerves, three pairs, descend into the pelta, curving along the entire borders, camptodrome. The median nerve is stronger and more marked in this species than in *M. grandis* Lesq., and the secondaries less distant, more numerous (seven to eight pairs, besides the basilar ones), and all branch in passing more or less obliquely and slightly curved to the borders. The nervilles are distinctly seen in the upper part of the leaf and are close, at right angles to the secondaries, flexuous, rarely branching.

A marked relation of this leaf is with *M. grandis* Lesq., from which it differs by its smaller size, the more numerous secondaries, and the dentate borders. *M. dentatus* Heer[1] appears still more closely related to this, but it is a fragment of a larger leaf which seems to be partly lobate and partly dentate.

Habitat: Ellsworth County, Kansas. No. 785 of the museum of the University of Kansas. Collected by E. P. West.

MACCLINTOCKIA CRETACEA Heer.

Pl. LIX, Fig. 4.

Fl. Foss. Arct., vol. 6, Abth. 2, p. 70, Pl. XXXVI, Figs. 1, 2a; Pl. XXXVII, Figs. 2–4.

A fragment of a leaf which is elliptical, with entire borders, five-nerved from the base, nerves acrodrome, slightly diverging.

The fragment is like those of the species as figured by Heer, especially Pl. XXXVII, Figs. 2–4 (loc. cit.), showing only the lower part of a leaf 4^{cm} long and 1.5^{cm} broad. The leaf is elliptical, entire on the borders, five-nerved from the base; the median nerve broadest; the lateral, nearest to the borders, are very thin; the texture is coriaceous, its areolation punctulate or reticulate. The second lateral nerve, between the midrib and the marginal ones, has a few branches from near the base like that in Heer's Pl. XXXVII, Fig. 2 (loc. cit.), in which the marginal one is thin and more proximate to the borders of the leaf.

By the irregular disposition of the nerves near the base, the fragment has some likeness to *Hakea arctica* Heer (Fl. Foss. Arct., vol. 1, Pl. XV, Fig. 5), the leaves of which are broader and shorter.

The fragment from Kansas bears a line of parasites which are oval, acute at the lower part, concave, with a convex point in the middle; they are placed along the lateral nerves in a row of ten or more and by their

[1] Fl. Foss. Arct., vol. 6, Abth. 2, p. 92, Pl. XXXVIII, Fig. 4.

position are comparable to *Sclerotium cinnamomi* Heer (Fl. Foss. Arct., vol. 4, pt. 3, Pl. I, Figs. 2, 2b).

Habitat: Probably Ellsworth County, Kansas. In the Snow collection of the museum of the University of Kansas.

Order ANONACEÆ.

Tribe XYLOPIEÆ.

ANONA CRETACEA Lesq.

Cret. and Tert. Fl., p. 77.

Order MAGNOLIACEÆ.

Tribe MAGNOLIEÆ.

MAGNOLIA TENUIFOLIA Lesq.
Pl. XXIV, Fig. 1.

Am. Jour. Sci. and Arts (series 2), vol. 46, 1868, p. 100; Cret. Fl., p. 92, Pl. XXI, Fig. 1.

Leaves large, oblong, entire, narrowed upward to a blunt point (broken), downward to a thick petiole; median nerve thick; secondaries open, parallel, alternate, inequidistant, forking at a distance from the borders, with branches anastomosing in bows near to the borders, camptodrome; the lower gradually shorter, at right angles to the median nerve and like tertiaries, curving backward.

The part figured here is a fragment comprising about half of a leaf which originally must have measured at least 20^{cm} in length, and from 8^{cm} to 9^{cm} in width at the middle. When compared with the leaf in the Cret. Fl. (loc. cit.), it completes the characters of this fine species, as in this last figure the shape of the leaf is clearly seen, while in that figured here the nervation is distinct to the base of the leaf. The midrib is here larger and the secondaries much thicker. But the fragment represents the under side of a leaf while the other is the impression of the upper surface. There is therefore no real difference in the characters. The angle of divergence of the secondaries is the same in both (50° to 55°). The remains of few tertiary intermediate veins, indistinctly seen between the more distant secondaries in Cret. Fl., Pl. XXI (loc. cit.), are represented on the figure of Pl. XXIV, Fig. 1, and in both leaves the basilar tertiaries are obsolete and no secondary is marked in the space occupied by them toward the base of the leaves.

The species is related to *M. Inglefieldi* Heer of the Tertiary of Greenland, as figured in Fl. Foss. Arct., vol 7, p. 121, Pl. LXIX, Fig. 1; Pl. LXXXV, Fig. 3; Pl. LXXXVI, Fig. 9, which differs by the secondaries branching and curving nearer to the borders, slightly more open in the lower part of the leaves and continuing in size and direction to the basal border, the lower pair being more oblique and running upward as a marginal nerve. The real or more marked affinity of the Cretaceous leaf is with those of the living *M. umbrella* Lam., the leaves of which are thin, nearly of the same size and form as those of the Dakota Group, and have a nervation really identical, the secondaries passing in the lower part of the leaves to short tertiaries or nervilles nearly at right angles, while upward the secondaries are forked above the middle and have the branches anastomosing in double rows along the borders as in the fossil species.

Habitat: Kansas. No. 780 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

MAGNOLIA PSEUDOACUMINATA, sp. nov.
Pl. XXIV, Fig. 2.

Leaves subcoriaceous, of medium size, entire, short petioled, broadly ovate-lanceolate, narrowed in curving to the petiole, decurring to it at the base, more gradually attenuated upward to the apex, subacuminate; median nerve strong and straight, not thick; secondaries parallel, more distant in the middle and upper part of the leaf, ramose near the borders, camptodrome.

The leaves average 12^{cm} in length and nearly 6^{cm} in width at the middle, and the petiole preserved entire is 13^{mm} long. The secondaries, of which there are twelve pairs, diverge $35°$ to $40°$ from the median nerve and all preserve the same degree of obliquity. A few of them are more distant and separated by thinner and shorter tertiaries and the areas are traversed by flexuous, thin nervilles somewhat oblique to the secondaries.

These leaves have the nervation and the form of those of the living *M. acuminata* L., the well known cucumber tree. Indeed, they are so remarkably similar to the small leaves of this species that no difference of characters is observable. Compared to *M. Capellinii* Heer,[1] which is one the best of the numerous leaves figured of the species, the base is not as widely decurring in *M. pseudoacuminata* but attenuated in rounding to the very short slightly decurring base. The leaves figured by Heer in the

[1] Fl. Foss. Arct., vol. 3, pt. 2, Pl. XXXIII, Fig. 3.

same work[1] have a still greater affinity to this species in size and form. They are, however, not acuminate but merely pointed.

Habitat: Ten miles northeast of Delphos, Kansas. No. 4079 of the collection of Mr. R. D. Lacoe.

MAGNOLIA AMPLIFOLIA Heer.
Pl. XXIV, Fig. 3.

Kreidefl. v. Moletein, p. 21, Pl. VIII, Figs. 1, 2; Pl. IX, Fig. 1.

Leaves large, subcoriaceous, entire, elliptical, short pointed; median nerve very thick; secondaries strong, much curved toward the borders, camptodrome.

This leaf is 18^{cm} long and 6^{cm} broad, with the median nerve more than 3^{mm} in diameter toward the base, which is much smaller than the two figured by the author. Nevertheless the identification of the Kansas leaf with those from Moletein seems legitimate. Not only is the form of the leaves the same but even their inclination to one side; and the secondaries, about of the same number (twelve pairs), are of the same character, strong and more open from the middle to their point of union to the median nerve, which they reach by a short, downward curve. The secondaries are also sometimes separated by thinner, shorter tertiaries. Few, however, are seen in the figures of the Moletein Flora, there apparently omitted, as the nervilles are figured only upon a small fragment of Pl. VIII, Fig. 1, showing these to be broken in the middle by divisions at right angles, as in the American specimens. Heer compares his species to *L. acuminata* L., to which indeed it is closely related. But the differences may be easily remarked in comparing Figs. 2 and 3 of Pl. XXIV. Heer remarks that the secondaries in *M. amplifolia* are thin as compared to the median nerve, and especially toward their ends they become so reduced that they can scarcely be followed with the eye. On the American specimens the secondaries are rather thick in the lower part, becoming gradually very thin in the upper. The species essentially differs from *M. pseudoacuminata* by the thickness of the midrib and the short, curved point.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4127 of the collection of Mr. R. D. Lacoe.

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[1] Fl. Foss. Arct., vol. 6, Abth. 2, Pl. XXV, Figs. 1, 2, 3.

MAGNOLIA ALTERNANS Heer.
Pl. XXXIV, Fig. 11.

Fl. Foss. Arct., vol. 3, pt. 2, p. 116, Pl. XXXIII, Figs. 5, 6; Pl. XXXIV, Fig. 4; vol. 6, Abth. 2, p. 91, Pl. XXI, Fig. 2; Pl. XLVI, Fig. 21; Lesquereux, Cret. Fl., p. 92, Pl. XVIII, Fig. 4.

The leaf figured here is better preserved than that figured in the Cret. Fl. (loc. cit.). It is broader, seemingly somewhat decurrent to the median nerve, and therefore like those of *M. Capellinii.* This last species has, however, still larger leaves and has the lateral nerves not separated by intermediate, shorter tertiaries. The differences between these two leaves and that of *M. pseudoacuminata* Lesq. are not very well defined, and some of the leaves appear referable to either of the three species.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4109 of the collection of Mr. R. D. Lacoe.

MAGNOLIA LACOEANA, sp. nov.
Pl. LX, Fig. 1.

Leaf large, broadly oval or nearly round, entire, obtuse or abruptly pointed at the apex, narrowed and subdecurring to the base. Median nerve somewhat thick, flexuous; secondaries alternate, parallel, declining to the midrib in joining it, curved and camptodrome, ascending very high along the borders with few branches in the upper part.

The leaf differs from the other fossil leaves referred to this genus by its nearly round form, its narrowing base and its numerous secondaries. The petiole is broken; the leaf is 10^{cm} long and 8.5^{cm} broad at the middle, with ten pairs of secondaries at an angle of divergence of 60°. By its size, and more especially by the base of the leaves, it has a degree of likeness to *M. Inglefieldi* Heer,[1] but differs greatly in the nervation.

Habitat: Ellsworth County, Kansas. No. 215 of the collection of Mr. R. D. Lacoe.

MAGNOLIA OBTUSATA Heer.
Pl. LX, Figs. 5, 6.

Fl. Foss. Arct., vol. 6, Abth. 2, p. 90, Pl. XV, Fig. 12; Pl. XXI, Fig. 3.

Leaves coriaceous, oblong or obovate, obtuse, gradually narrowed to a long petiole, entire; secondaries distant, simple, oblique, curved, camptodrome.

[1] Fl. Foss. Arct., vol. 1, Pl. XVIII, Fig. 1; vol. 2, pt. 4, Pl. LI, Figs. 4-7.

Heer (loc. cit.) has figured two fragmentary leaves, the upper part only of this fine species, which is distinctly characterized by the obtuse apex, the great distance and the position of the secondaries. The best preserved leaf of this species (Fig. 6) is 8^{cm} long, enlarged upward and obtuse at apex, the base gradually narrowing to the petiole, which is 2.5^{cm} long. It has five pairs of secondaries at unequal distances, alternate, more open in joining the midrib, at an angle of divergence of 50°, much curved in traversing the blade, simply camptodrome. The other leaf is larger, being 15^{cm} long, with apex partly destroyed and the secondaries equally distant, but a little less open in joining the midrib. Each of these leaves represents the essential characters of the species.

Habitat: Near Fort Harker, Kansas. No. 2786 of the U. S. National Museum.

MAGNOLIA BOULAYANA, sp. nov.

Pl. LX, Fig. 2.

Leaf coriaceous, oblong, equally narrowed and cuneiform at base as well as in rounding to the blunt apex, entire; borders parallel at the middle; midrib narrow; secondaries very thin, distinct, oblique, camptodrome, with few branches.

This leaf, which is 13^{cm} long and 4^{cm} broad, with parallel borders, has the aspect of a Laurus. It is, however, distinctly parallel on the borders, with all the secondaries, of which there are eleven pairs, equidistant, parallel, and at an acute angle of divergence (40°), as is *M. longepetiolata* Ett.[1] It resembles this last species, being, however, somewhat smaller and more rapidly narrowed to the base, with a narrow, percurrent midrib. It is closely allied, especially by its nervation, to *M. Ludwigii* Ett. of the European Oligocene.

Habitat: Ellsworth County, Kansas. No. 1191 of the collection of Mr. R. D. Lacoe.

MAGNOLIA SPECIOSA Heer.

Pl. LX, Figs. 3, 4.

Kreidefl. v. Moletein p. 20, Pl. VI, Fig. 1; Pl. X, Figs. 1, 2; Pl. XI, Fig. 1; Lesquereux, Cret. and Tert. Fl., p. 72.

Though the leaves are somewhat smaller than those figured by Heer in the Flora of Moletein, they are evidently referable to this species, since they differ from all the relatives, *M. Capellinii*, *M. amplifolia*, etc., by the long

[1] Flora v. Bilin, pt. 3, p. 9, Pl. XLI, Figs. 8, 9.

prolongation of the apex, the distant secondaries, and the decurrent base Heer describes the species as follows: Leaves very large, coriaceous, oval-elliptical, long acuminate at apex, narrowed at base to a strong petiole; primary nerve thick; secondaries much curved, camptodrome.

Habitat: Ellsworth County, Kansas. No. 221 and 222 of the collection of Mr. R. D. Lacoe.

MAGNOLIA CAPELLINII Heer.

Pl. LXVI, Fig. 1.

Phyll. Crét. du Nébr., p. 21, Pl. III, Figs. 5, 6; Lesquereux, Cret. and Tert. Fl., p. 72.

A peculiar form with thick leaves and secondaries deeply impressed; the impression is that of the lower face.

Habitat: Ellsworth County, Kansas. No. 1190 of the collection of Mr. R. D. Lacoe.

MAGNOLIA OBOVATA Newb.

Later Ext. Fl., p. 15; Illustr. Cret. and Tert. Pl., Pl. II, Fig. 2; Pl. IV, Fig. 4.

MAGNOLIA (CARPITES) species, Lesq.

Cret. and Tert. Fl., p. 73, Pl. XI, Fig. 6.

LIRIODENDRON PRIMÆVUM Newb.

Pl. XXIV, Fig. 4; Pl. XXVI, Fig. 1–4.

Later Ext. Fl., p. 12; Illustr. Cret. and Tert. Pl., Pl. VI, Fig. 7.

Leguminosites Marcouanus Heer, Proc. Acad. Nat. Sci. of Phil. (1858), p. 265; Dana's Manual of Geology, 2d ed., p. 459, Fig. 827; Cret. Fl., p. 90, Pl. XXVIII, Fig. 2.
Bumelia Marcouana (Heer) Lesq., Cret. Fl., p. 90, Pl. XXVIII, Fig. 2.
Phyllites obcordatus Heer Phyll. Crét. du Nébr., p. 266.
Liriodendron Meekii var. *Marcouana* Heer, Fl. Foss. Arct., vol. 6, Abth. 2, p. 88, Pl. XXII, Figs. 4, 6, 7, 11; Pl. XXIII, Fig. 3; Pl. XLV, Figs. 3a, 3b.
Liriodendron Meekii var. *obcordata* Heer (loc. cit.), p. 88, Pl. XXII, Figs. 1b, 2; Pl. XXIII, Fig. 4.
Liriodendron Meekii var. *mucronulata* Heer (loc. cit.), p. 88, Pl. XXII, Figs. 3, 10.

Leaves of medium size, somewhat thick but not coriaceous, oblong or obovate, more or less rapidly narrowed to a short petiole, entire, emarginate at apex, rarely enlarged and rounded near the base; primary nerve percurrent, sometimes emerging as a short, small mucro in the middle of the notched apex; secondaries oblique, parallel, passing straight or curved toward the borders, camptodrome or craspedodrome; angle of divergence 30° to 40°, according to the size of the leaves.

The leaves vary in size from 3.5^{cm} to 6^{cm} long, and from 2^{cm} to 5^{cm} broad at the middle, being either cuneiform or rounded, or even subtruncate or subcordate at the base. The secondaries, mostly simple, pass obliquely, either straight or a little curved, toward the borders, where they become effaced or a little curved up, seemingly camptodrome, while a few appear to run directly to the borders as craspedodrome.

Leaves of this kind have been found abundantly in the Cretaceous of Greenland and described and figured by Heer as quoted above; some also, but fewer, in the Dakota Group of Kansas, Nebraska, etc. In all these leaves there is no distinct contraction or division of the lamina in three lobes as in the following species.

Habitat: Pipe Creek, Cloud County, Kansas. No. 4090 (Pl. XXVI, Fig. 1) of the collection of Mr. R. D. Lacoe. Fig. 3 is copied from Heer, Fl. Foss. Arct. (loc. cit.); Fig. 2 is copied from Newberry (loc. cit).

LIRIODENDRON SEMIALATUM Lesq.
Pl. XXV, Figs. 2–4; Pl. XXIX, Fig. 3.

Leaves deltoid in outline, truncate-rounded or broadly cuneate at base, enlarged, round-lobed on each side in the lower part, ovate, obtuse or obtusely pointed at apex; median nerve straight; secondaries parallel, numerous, the lower pairs in the lobes craspedodrome, the upper subcamptodrome.

The leaves are of medium size, 7^{cm} to 9^{cm} long, but the round upper part of one seen on Pl. XXV, Fig. 4, apparently belongs to a much larger leaf. They are enlarged in the lower part into two opposite round lobes, abruptly rounding or cuneiform to the petiole, contracted above the lobe in more or less definite sinuses, then slightly enlarged upward and ovate or oblong rounded to an obtuse or obtusely pointed apex.

This species differs essentially from *L. primævum* and the other species of the genus by the entire, not emarginate apex, the leaves being thus merely once lobed on each side of the enlarged base instead of bilobate at the apex, and also by the numerous proximate secondaries, simple or forking near their extremities. The fragment (Pl. XVI, Fig. 4) may represent a different species. It has the secondaries more distant, more curved in passing toward the borders, and more distinctly camptodrome.[1]

[1] Prof. Lesquereux has left a very brief note relating to this species, in which he compares it to *L. Procaccinii* Ung. (Saporta and Marion, Fl. de Meximieux, Pl. XXXIII, Figs. 3–5). He then adds that "if these are same as *L. islandicum*, some of my species should be abandoned." As he has given no further indication of his wishes I have preferred to retain everything as he left it.—F. H. K.

Habitat: Seven miles from Glascoe, Kansas. Nos. 425 and 472 of the Museum of Comparative Zoology of Cambridge, Massachusetts. No. 126 of the collection of Mr. R. D. Lacoe, from Pipe Creek, Cloud County, Kansas.

LIRIODENDRON MEEKII Heer.

Pl. XXVIII, Figs. 5, 6.

Phyll. Crét. du Nébr., p. 21, Pl. IV, Figs. 3, 4; Newberry, Illust. Cret. and Tert. Pl., Pl. VI, Fig. 5; Lesquereux, Cret. and Tert. Fl., p. 73.

Leaves small, constricted in the middle, panduriform, round, lobate at base, deeply emarginate; lobate at apex.

The species is represented only by the two figures copied in Heer's Phyll Crét. du Nébr. (loc. cit.), from figures communicated by Dr. F. V. Hayden. The same figures have also been reproduced in Newberry's Illustr. (loc. cit.). No other leaves of this character have been found either in Greenland or in Kansas. Prof. Heer has considered them as mere varieties of the preceding species, of which the leaves have been abundantly found in Greenland, and has described them in Fl. Foss. Arct., vol. 6, Abth. 2, p. 89, as *L. Meekii* var. *genuinum*. As far as can be seen from the figure the difference is in the smaller size of the leaves of the so-called variety, and the contraction in the middle producing two round, lateral, basilar lobes, and by emargination of the apex two upper lobes of the same character.

These leaves do not appear to merely represent a variety but a species, derived from the original simple form by median contraction producing more complex, lobed leaves. To strengthen his supposition that the lobate form is a mere variety, Prof. Heer recalls the fact that *L. tulipifera* L. has not only leaves of very different size, but also of various forms, among them some nearly circular small ones not at all lobate, but merely flat or emarginate at apex, like that of Pl. XXIX, Fig. 4. But the small leaves of the living species are undeveloped forms appearing later at the base of the annual branchlets, and always very few in number in comparison to those of a normal form and of a whole tree. In case of preservation by fossilization they should, of course, be very rarely found, while those of a perfect state of conformation would be most common. Here we have, on the contrary, an abundance of the entire leaves merely emarginate at apex, most of all being larger than the compound ones. I therefore regard the simple form as the original, the others as local, though derived from it; and these of course may be admitted as varieties or as species. From the remarkable diversity of characters seen in the leaves of Liriodendron described in this volume, I believe that no botanist would be disposed to consider them as mere varieties of the original, obovate, simple leaves.

Habitat: Nebraska. Specimens not seen.

LIRIODENDRON GIGANTEUM Lesq.

Pl. XXV, Fig. 1; Pl. XXVI, Fig. 5; Pl. XXVII, Fig. 1.

Cret. Fl., p. 93, Pl. XXII, Fig. 2; Cret. and Tert. Fl., p. 74.

Leaves large, broadly bilobate on each side, deeply emarginate at apex; lobes at right angles or oblique, oblong, obtuse; sinuses deep, comparatively narrow; lateral nerves simple, oblique, parallel, straight, and stout.

There are many leaves of this species, all large, the largest (Pl. XXVI, Fig. 3) measuring 16.5^{cm} in width between the extremities of the lower lobes, 10^{cm} in length from the top of the petiole (broken) to the apex of the median nerve, or 16^{cm} to the top of the upper lobes. The secondaries, which of course follow the angle of divergence of the lobes, are at an angle of 50° to 80° to the median nerve. The leaf (Pl. XXV, Fig. 1) has the lobes more oblique, narrower, while that shown in Pl. XXVII, Fig. 1, has the lobes more open and more deeply divided. But all are evidently of the same species and of the same character as the one described in Cret. Fl., p. 93, Pl. XXII, Fig. 2, which is only a fragment of the upper part of an apicial lobe.

Habitat: Two miles from Glascoe, Kansas. Nos. 206, 335, and 513 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

LIRIODENDRON GIGANTEUM var. CRUCIFORME Lesq.

Pl. XXVIII, Figs. 1, 2.

***Liriodendron cruciforme* Lesq., Cret and Tert. Fl., p. 74; Bull. Mus. Comp. Zool., Cambridge, vol. 7, pt. 6, 1881, p. 227.**

This variety as seen from better preserved specimens merely differs from the normal form by the lobes being nearly at right angles, more deeply cut to the narrow sinuses, less oblique and merely obtusely pointed; the nervation is of the same type.

Habitat: Elkhorn Creek, Kansas. Nos. 192 and 197 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

Liriodendron intermedium Lesq.
Pl. XXV, Fig. 5.

Cret. Fl., p. 93, Pl. xx, Fig. 5; Cret. and Tert. Fl., p. 74.

Leaves large, narrowly bilobate at the base, deeply emarginate by the upward direction of the upper borders, forming oblong, lanceolate obtuse lobes far distant from the lower ones.

Of this species, which as yet is not sufficiently known, a second specimen has been obtained representing, like the first described in Cret. Fl. (loc. cit.), merely the upper part of a leaf. The space between the upper and lower lobes is long, and thus the sinuses which separate them are scarcely observable, though at its base the specimen shows an evidently enlarging part or the origin of a lobe apparently large and at right angles. The secondaries are less distant than in *L. semialatum* and are camptodrome.

Habitat: Two and one-half miles from Glascoe, Kansas. No. 504 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

Liriodendron acuminatum Lesq.
Pl. XXVII, Figs. 2, 3.

Cret. and Tert. Fl., p. 74; Bull. Mus. Comp. Zool., Cambridge, vol. 7, pt. 6, 1881, p. 227.

Leaves smaller, about half as large as those of *L. giganteum*, cut laterally into two pairs of narrow, linear, acuminate lobes.

The leaves, which are not coriaceous, though thickish, are rounded or truncate at base; the lobes, diverging 40° to 50° from the median nerve, 10^{mm} to 12^{mm} broad, 5^{cm} to 7^{cm} long, are separated by long or broad sinuses; the upper ones are shorter than the lower, each traversed in the middle by a strong craspedodrome secondary nerve with a second thin and camptodrome nerve near the basal border. None of the nerves are branching; no nervilles are distinct.

Habitat: Two miles south of Glascoe, Kansas. Nos. 504a and 508 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

Liriodendron acuminatum var. bilobatum n. var.
Pl. XXVIII, Fig. 4.

Leaves of the same character as those of the normal form, differing by the lower lateral lobes being cut to the middle into two obliquely diverging, lanceolate, obtusely pointed lobes.

This form, which was originally considered as a species, is really a mere variety of *L. acuminatum*, from which it differs by the subdivision of the lower lobes, like that often observed in the leaves of Aralia. It is an anomaly in the genus Liriodendron. Nevertheless a subdivision somewhat like that of this leaf is remarked in the leaf of *L. islandicum* Sap. & Mar. (Fl. de Meximieux, Pl. XXXIII, Fig. α), considered by some authors as a variety of *L. Procaccinii* Ung. It has the lower lobes cut into two sharply pointed lobes, though the base of the leaves is generally entire, as in *L. Procaccinii* Ung., as well as in those of the living *L. tulipifera* L. The character of nervation is the same in the variety as in the normal form, there being merely two lateral nerves in each lobe instead of one.

Habitat: Near Fort Harker, Ellsworth County, Kansas. Nos. 10b and 10c of the museum of the University of Kansas; A. Wellington, collector.

Liriodendron Wellingtonii, sp. nov.

Pl. XXVIII, Fig. 3.

Leaves coriaceous, of medium size, divided laterally into two long, linear obtuse lobes ascending at an acute angle of divergence, the lower nearly twice as long as the upper ones, curving inside; lateral nerves thin, parallel.

This fine leaf could scarcely be understood without a figure. It is broadly wedgeform and rounded at base to a thin petiole; the lower lobes, diverging at base at an angle of 40°, soon curve inward, ascending nearly vertically from the middle to the somewhat enlarged, obtuse apex; the upper are shorter, at an angle of divergence of 40°.

Though of a type closely related to that of *L. acuminatum*, this leaf can not be considered as a variety of that species, except by admitting that all the forms described here are mere modifications of an original extremely variable type whose leaves could all have been growing upon the same tree and are therefore not separable into species. From the diversity of the leaves described here this supposition is certainly not admissible.

Habitat: Near Fort Harker, Ellsworth County, Kansas. Collector, Mr. A. Wellington, to whom the species is dedicated. Nos. 11 and 11b of the museum of the University of Kansas.

LIRIODENDRON PINNATIFIDUM Lesq.
Pl. XXVII, Figs. 4, 5.

Cret. and Tert. Fl., p. 75; Bull. Mus. Comp. Zool. Cambridge, vol. 7, pt. 6, 1881, p. 227.

Leaves coriaceous, with surface polished, linear, pinnately alternately lobed; lobes short, obtuse truncate or angular, abruptly narrowed into an obtusely lobate or subtruncate apex, separated by broad, unequal sinuses.

This form is very peculiar; but although the specimen is fragmentary, it appears clearly defined and referable to this genus. The fragment preserved is 10^{cm} long, 4^{cm} broad at the middle, a little narrowed upward to a truncate apex and downward to the rounded base. It is cut on each side into three alternate short obtuse or truncate lobes, separated by broad, flat or half round sinuses, the lower of which are much shorter than the upper ones. The lateral nerves are close, numerous, camptodrome, often forking near the borders, where they become effaced, their angle of divergence being 50°.

The fragment (Fig. 5) appears to be referable to this species, though its nervation, which is of the same type as that of Pl. XXV, Fig. 4, is different from that of Pl. XXVII, Fig. 4. The nervation of this last fragment is of the same character as that of *L. semialatum* as seen in Pl. XXV, Figs. 2, 3, where the nerves are quite as proximate at the same angle of divergence, forked and effaced near the borders.

Habitat: Two and one-half miles from Glascoe, Kansas. Nos. 526 and 531 of the Museum of Comparative Zoology of Cambridge, Massachusetts.

LIRIODENDRON SNOWII, sp. nov.
Pl. XXIX, Figs. 1, 2.

Leaves large, ovate in outline, emarginate at apex, pinnately, horizontally divided into linear, obtuse lobes, distant and distinct for their whole length, attached by their whole base to the thick median nerve-like pinnules of a compound leaf, curved down at base or slightly decurring to the midrib, inclined upward and somewhat enlarged to their outer end, each with one or two secondaries, parallel, the upper near to the borders, the lower stronger, more prolonged, both joined and anastomosing with thin, marginal tertiaries which follow close to the borders in festoons.

The leaves are so remarkably different from those of the normal form of Liriodendron, that it is at first difficult to see how they are identified with the genus. Nevertheless, considering the divisions and subdivisions of the lamina into linear, acute or obtuse lobes in *L. acuminatum*, *L. Wellingtonii*, *L. pinnatifidum*, etc., one is forced to admit, especially from the character of the nervation, that they pertain to Liriodendron.

The fragments show the essential parts of what at first seem to be compound leaves. The lobes on each side of the median nerve are subopposite, about 5^{cm} long, 1^{cm} broad near the base, 17^{mm} toward the apex, where they are either entire, obtuse, or lobate, separated by a distance about equal to that of their width, like the lobes of *L. pinnatifidum*, which, however, are not cut deep to the median nerve. This remarkable species shows more than any other of the genus the tendency to variability in the leaves of the Dakota Group.

Habitat: Ellsworth County, Kansas. No. 4 of the museum of the University of Kansas; A. Wellington, collector. Fig. 2 is that of a specimen recently sent from Kansas, now in the collection of Mr. R. D. Lacoe.

LIRIOPHYLLUM OBCORDATUM Lesq.
Pl. XXVIII, Fig. 7.

Cret. and Tert. Fl., p. 77.

Leaf obovate, deeply emarginate or split at apex, in the direction of the midrib, narrowed and cuneate to the base; median nerve narrow, rigid; secondaries few, thin, at an acute angle of divergence, simple, oblique, effaced near the borders.

This small leaf, by its deeply, narrowly emarginate apex and by its nervation, has its affinity more distinctly marked with Liriophyllum than with Liriodendron. It is nearly 3^{cm} long, not quite 1.5^{cm} broad in the upper part, with two pairs of thin secondaries ascending high at an angle of divergence of 30° and curving at a distance from the borders; the petiole is destroyed. Though comparable to some of the figures given by Heer as varieties of *Liriodendron Meekii*, it evidently differs in essential characters, viz, the prolongation of the upper pair of secondaries to near the apex of the upper borders or lobes of the leaf, as in those of *Liriophyllum populoides* Lesq. (Cret. and Tert. Fl., Pl. XI, Figs. 1, 2).

Habitat: Near Fort Harker, Kansas. Specimen in the Museum of Comparative Zoology of Cambridge, Massachusetts.

LIRIOPHYLLUM BECKWITHII Lesq.

Cret. and Tert. Fl., p. 76, Pl. x, Fig. 1; Hayden's Ann. Rept., 1876, p. 482.

LIRIOPHYLLUM POPULOIDES Lesq.

Cret. and Tert. Fl., p. 76, Pl. XI, Figs. 1, 2.

CARPITES LIRIOPHYLLI Lesq.

Cret. and Tert. Fl., p. 77, Pl. XI, Fig. 5.

DEWALQUEA DAKOTENSIS, sp. nov.

Pl. LIX, Figs. 5, 6.

Leaves large, compound, with a main petiole somewhat thick as seen from the fragment figured, pedate-digitate, tripartite, segments or leaflets petiolate, lanceolate, entire, obtuse or apiculate, broken at apex; median nerve stout; secondaries variable in distance, parallel, oblique, and camptodrome.

One of the leaflets, which is half as long as the others, appears to be a lateral one, being gradually enlarged up to near the apex, there rounding to a short mucro.

These fragments are comparable to the leaflets of *Dewalquea gelindenensis* Sap. & Mar.[1], being especially like Fig. 3 of this last plate, the leaves from Kansas having the leaflets a little broader, the main pedicel slightly thicker, the pedicels of the leaflets of the same size and length, naked from the base of the leaflets which are narrowed at base to the petiole and join it without decurring to it.

The leaflets are apparently long, but the upper part is destroyed. The preserved fragment is 8^{cm} long, with a petiole 1^{mm} to 2^{mm} broad. One of them (Pl. LIX, Fig. 5) bears on the side the remains of the common petiole. The leaflets generally become narrowed near the apex to a short acumen, or become mucronate, as in the smaller leaflet mentioned above, which is only 4^{cm} long and 2^{cm} broad in its upper part.

None of the species described by Heer from the Cretaceous of Greenland. *D. insignis* Heer,[2] with the dentate leaflets; *D. grœnlandica* Heer,[3] also described from Patoot, with leaflets gradually narrowed and decurring to the petiole, nor *D. heldemiana* Sap. & Mar., described from mere fragments in the Patoot Flora, have even a distant relation to the species from Kansas.

Habitat: Kansas.

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[1] Vég. Marnes Heers. Gelind., p. 61, Pl. VIII, Figs. 3, 4; Pl. IX, Figs. 1–7.
[2] Fl. Foss. Arct., vol. 6, Abth. 2, p. 86, Pl. XXV, Fig. 7; Pl. XXXIII, Figs. 14–16.
[3] Loc. cit., p. 87, Pl. XXIX, Figs. 18, 19; Pl. XLII, Fig. 6; Pl. XLIV, Fig. 11.

GENERA AND SPECIES OF UNCERTAIN RELATION.

ASPIDIOPHYLLUM DENTATUM Lesq.
Pl. XXXIX, Fig. 1.

Cret. and Tert. Fl., p. 88.

Leaves large, palmately three nerved from above the base; five-lobate by the division of the lateral lobes; lobes oblong, obtuse, and obtusely dentate or deeply undulate on the borders; primaries rather narrow. The leaf is constricted at base into a fanlike obtusely five-toothed shield, covering the top of the petiole.

This species has been described from the specimen figured here. In comparison with the leaves of *A. trilobatum* this one is somewhat smaller, but a large leaf nevertheless. From the forking of the primary lateral nerves above the base it is evident that the leaf is five-lobate; but as yet I have not seen any specimens indicating the form of these lateral lobes, none of the leaves of *A. trilobatum* showing a disposition to a five-lobate division. The leaf is comparable to that of *Sassafras (Araliopsis) dissectum* (Pl. XIV, Fig. 1), the form of the median lobe and the disposition of the secondaries being about the same in both leaves, differing much, however, by the basilar appendage or stipule and the more obtusely dentate or lobed borders.

The basilar shield of Aspidiophyllum has a great affinity to the basilar expansion remarked upon some of the largest leaves of *Platanus occidentalis*, which are sometimes prolonged downward to a round, entire, or lobed stipular base, covering the upper part of the top of the petiole or of the median nerve in its continuation to the petiole, which passes underneath. This, as has already been remarked, is not the only point of affinity that the leaves of Sassafras (Araliopsis) and Aspidiophyllum have with those of Platanus, the nervation of all being of the same type.

Habitat: Probably Ellsworth County, Kansas. No. 614 of the collection of the Museum of Comparative Zoology, of Cambridge, Massachusetts.

ASPIDIOPHYLLUM PLATANIFOLIUM Lesq.

Cret. and Tert. Fl., p. 88, Pl. II, Fig. 4.

ASPIDIOPHYLLUM TRILOBATUM Lesq.

Cret. and Tert. Fl., p. 87, Pl. XII, Fig. 1; Pl. XIII, Figs. 1–5; Pl. XIV, Fig. 1.

EREMOPHYLLUM FIMBRIATUM Lesq.

Cret. Fl., p. 107, Pl. VII, Fig. 1.
Ficus ? fimbriata Lesq., Am. Jour. Sci. and Arts, series 2, vol. 46, 1868, p. 96.

PHYLLITES ILICIFOLIUS, sp. nov.
Pl. X, Fig. 9.

Leaf thick, coriaceous, entire, oblong lanceolate, rounded at base and apex? (destroyed); median nerve very thick, disproportionally so in comparison to the lateral nerves; secondaries distant, straight and oblique to above the middle, there abruptly curved upward, ascending parallel to the borders, but at a distance from them, emitting from the back of the bows oblique or curved nervilles toward the borders.

The conformation of the leaf is peculiar. Its preserved part, which is 10^{cm} long and 5^{cm} broad toward the base, has a median nerve 3^{mm} in diameter in its lower part, above the short petiole, and six pairs of secondaries diverging 50° to 60°, going straight up to a distance from the borders and anastomosing in forming flat bows, a nervation similar to that of the leaves of *Hedycarya arborea* J. et G. Forst, of New Zealand.

The leaf has a distinct affinity to *Ilex borealis* Heer, of which a leaf is represented in Pl. XXXV, Fig. 8.

Habitat: Ellsworth County, Kansas. No. 208 of the collection of Mr. R. D. Lacoe.

PHYLLITES LACOEI, sp. nov.
Pl. XLV, Fig. 6.

Leaf very thick, petioled, flabelliform, enlarged on the side, broader than long, subtruncate at base, crenulate all around; primary nerve thick, percurrent; secondaries inequidistant, parallel, seven pairs, the lower opposite, the upper alternate, craspedodrome with their few branches; areolation very small, quadrate.

This leaf has some likeness to that of Pl. XLV, Fig. 2, described as *Protophyllum crassum*, but by its form only, for the nervation is pinnate, the lower secondaries from the base of the leaf oblique, at an angle of divergence of 40°, running straight to the borders, with few thinner branches, all craspedodrome.

Habitat: Kansas. No. 4156 of the collection of Mr. R. D. Lacoe.

PHYLLITES SNOWII, sp. nov.
Pl. XXXVIII, Fig. 2.

Leaf large, of thin texture, ovate, obtuse, truncate and inequilateral at base, minutely dentate; primary nerve narrow, secondaries thin, open, nearly straight and parallel, the lower branching.

The leaf, which is 10^{cm} long and 9^{cm} broad in the middle, has the aspect of a leaf of Platanus, and also resembles, in some characters, leaves of Protophyllum. It differs from both by its abnormal form, being inequilateral or more prolonged at base on one side than on the other. Its nervation is pinnate, the secondaries being all alternate, eight pairs, at an angle of 60°, the lowest branching and anastomosing in bows along the truncate base without connection to a basilar veinlet; the others craspedodrome as well as their divisions; nervilles distinct and distant, simple and flexuous.

I do not know of any distinct relationship of this leaf to any fossil species. It is comparable to *Alnites grandifolius* Newb. (Illustr. Cret. and Tert. Pl., Pl. IV, Fig. 2), a fragment without description, in which the relation to Alnus is very obscure. On account of the leaf being inequilateral it might rather be compared to some species of Ulmus, as *U. crassinervia* Ett. (Flora v. Bilin, p. 63 (139), Pl. XVIII, Figs. 28 and 29), or *U. diptera* Steenstr., as represented by Heer in Fl. Foss. Arct., vol. 1, p. 149, Pl. XXVII, Fig. 3.

Habitat: Ellsworth County, Kansas. No. 765 of the museum of the University of Kansas; E. P. West, collector.

PHYLLITES VANONÆ Heer.
Pl. XX, Fig. 9; Pl. XLII, Fig. 5.

Phyll. Crét. du Nébr., p. 22, Pl. I, Fig. 8; Lesquereux, Cret. Fl., p. 113, Pl. XX, Fig. 7; Pl. XXVIII, Fig. 8.

Leaves of this species of medium size, entire, ovate, blunt at apex, generally without any trace of nervation as described (loc. cit.), are not rare in the Dakota Group. Those I have figured here have the secondaries distinct though very thin. The secondaries are opposite, proximate, seventeen to eighteen pairs on one of the leaves, the largest more distant on the other, where they are partly effaced. This nervation and also the form of the leaves seem to refer them to Ficus or to some Leguminosites. They are comparable for their form to *Ficus pulcherrima* Sap.,[1] which has the sec-

[1] Études, pt. 1, Pl. VII, Fig. 2.

ondaries of the same type but more distant and more curved, and also to *Leguminosites phaseolites* Heer.[1] All of these leaves are fragmentary and much smaller; Figs 8–10 have the secondaries close, at an acute angle of divergence, camptodrome, like those of Fig. 9. The relation is distant.

Habitat: Kansas. Represented in all the collections named.

PHYLLITES LAURENCIANUS, sp. nov.
Pl. XLIV, Fig. 5.

Leaf small, truncate at base, lanceolate acuminate, not coriaceous but with polished surface, pinnately nerved; median nerve rigid, secondaries six pairs, equidistant and parallel, arched near the borders and incumbent in marginal, distinct, simple bows.

This leaf, which is 3^{cm} long and 2^{cm} broad, is broken at the base, but is apparently truncate, inequilateral, slightly curved at the sharply pointed apex. No relation is as yet found to it.[2]

Habitat: Ellsworth County, Kansas. No. 846 of the museum of the University of Kansas. Collected by E. P. West.

PHYLLITES PERPLEXUS, sp. nov.
Pl. XXXVIII, Fig. 15.

A transverse fragment of a compound leaf with two opposite, very small leaflets, at right angles to the rachis, 5^{mm} long, a little more than 1^{mm} broad, linear, entire, obtuse, slightly curved upward with a thin, median nerve and two pairs of alternate, oblique secondaries curving toward the borders. Fragment of uncertain relation.

Habitat: Ellsworth County, Kansas. No. 797 of the museum of the University of Kansas; E. P. West, collector.

PHYLLITES CELATUS, sp. nov.
Pl. LXI, Fig. 1.

Leaf enlarged, round, oval, entire at apex, gradually passing downward into a narrow, linear, flat collum, abruptly enlarged at its base into a broader, round appendage or pelta, pierced at the middle and traversed by the base of the midrib, which passes underneath; midrib of medium size, straight and distinctly marked; secondaries in the round part of the leaf, straight, oblique, equidistant, strong, parallel, craspedodrome, with few

[1] Fl. Foss. Arct., vol 3, pt. 2, p. 118, Pl. XXXIV, Figs. 7–11.

[2] In a subsequent brief note Prof. Lesquereux adds: "A leaf in Engelhardt, Nova Acta, vol. 38, 1876, Pl. XXVII, Figs. 25–27, named *Cassia cordifolia* Heer, has form and size of my Fig. 5, Pl. XLIV, but it has no nerves. It (mine) can, however, be named Cassia or Leguminosites."—F. H. K.

branches, those of the column irregular, at right angles to the midrib, curved upward; those of the pelta descending to it from the base of the midrib, there diversely ramose.

Habitat: Near Fort Harker, Kansas. No. 2722 of the U. S. National Museum.

PHYLLITES sp.

Pl. LIX, Fig. 7.

A mere fragment, being only the lower half of an entire coriaceous leaf, which is lanceolate, narrowed to the base of the midrib, which is slightly enlarged into a very short petiole, penninerved; median nerve comparatively strong; secondaries very oblique, parallel and equidistant, straight or undulate in passing toward the borders, camptodrome, anastomosing in short bows at a distance from the borders, which they follow in double areoles.

The divergence of the secondaries is only 30°, there being seven pairs of secondaries, which are very distinct upon the fragment of a leaf, which is only 5^{cm} long and about 3^{cm} broad at the middle. The secondaries are deep and strong, except the lowest, which are comparatively very thin and follow the borders, where they anastomose with branches of that above it.

The fragment is comparable to the leaf of *Laurus Haidingeri* Ett., as figured in Fl. v. Bilin, pt. 1, Pl. xxx, Fig. 8, at least for its peculiar nervation.

Habitat: Kansas.

PHYLLITES STIPULÆFORMIS, sp. nov.

Pl. LXI, Fig. 2.

Apparently the upper part of two leaflets of a compound or bifid leaf whose real form is consequently unknown. The fragment is of coarse texture, irregularly ovate, truncate or lacerate at base, obtuse; the two apices turned toward each other, the nervation very coarse and irregular, more like that of a double leaf-like stipule, the secondary nerves parallel or diverging above with short, thick branches, straight or oblique to the borders, and deep nervilles variable in distance and direction.

Habitat: Kansas.

PHYLLITES EROSUS, sp. nov.

Pl. LXI, Fig. 4.

Leaf of medium size, coriaceous, ovate, lanceolate, obtuse at apex, narrowed and cuneiform at the base, entire, irregularly cut at the border as if gnawed into by animals, petiolate; midrib percurrent; secondaries nearly at right angles to it, slightly curved in passing toward the borders, numerous, abruptly curved and incumbent near the borders, camptodrome.

The leaf could be compared to some species of Ficus, like *F. multinervis* Heer, by its nervation; but the petiole is like a continuity of the midrib, being flat and narrow. The secondaries are numerous, nearly at right angles, with some trace of thinner, parallel tertiaries, which, however, are scarcely observable; the areolation is totally obsolete. The leaf is 7.5^{cm} long, nearly 3^{cm} broad at the middle, with a petiole 1.5^{cm} long, apparently broken. The secondaries are 3^{mm} to 4^{mm} distant at the base, and diverge from the midrib at an angle of 70°.

Habitat: Near Fort Harker, Kansas. No. 2726 of the U. S. National Museum.

PHYLLITES AMISSUS, sp. nov.

Pl. LXII, Fig. 1.

Leaf of medium size, coriaceous, elliptical, emarginate at apex, entire, slightly narrowed toward the base and rounding in joining the median nerve; midrib thick or rather stout, nearly equal its whole length; secondaries eleven to twelve pairs, open, diverging 60° from the midrib, slightly curving, disappearing before reaching the borders, apparently camptodrome.

The leaf is 9.5^{cm} long, 4^{cm} wide in the middle. The leaf is emarginate at the apex and by its form may be compared to *Sapotacites retusus* Heer,[1] but the nervation is of a far different type. As yet the generic relation is not known. Rather referable to Bombax and comparable to *B. oblongifolium* Ett.,[2] from which it differs by the broader, oval size of the leaves and the somewhat longer secondaries.

Habitat: Near Fort Harker, Kansas. No. 2756 of the U. S. National Museum.

PHYLLITES ARISTOLOCHIÆFORMIS, sp. nov.

Pl. LIX, Fig. 8.

Leaves sagittate-hastate, auricled at base, tapering up from the base and acuminate, entire; texture thin; midrib narrow, percurrent; secondaries oblique, camptodrome, very thin; nervilles curved and branching into a large irregular areolation.

This leaf is 5^{cm} long and 3^{cm} broad above the base, where it is rounded into unequal lobes or auricles, only one descending lower than the base

[1] Fl. Foss. Arct., vol. 7, p. 32, Pl. LXI, Fig. 10.
[2] Fl. v. Bilin, pt. 3, Pl. XLII, Fig. 10.

of the midrib. It appears of thin texture, the midrib being narrow; the secondaries numerous, parallel, at an acute angle of divergence of nearly 50°, and a little curved in passing toward the borders, incumbent and camptodrome.

The form of the leaf, at least in its lower part, is very similar to that of the fragment of *Aristolochia inæqualis* Heer (Fl. Foss. Arct., vol. 7, Pl. XCII, Fig. 2), from the Miocene of Bear Island. But the whole leaf does not show the character of the leaves of Aristolochia, as all the secondaries appear oblique from the midrib, none of the lower being turned downward into the lobes or auricles. Except for this difference the nervation and areolation correspond to that of the leaf figured by Heer (loc. cit.), being also similar to it by the unequally lobed base.

Habitat: Ellsworth County, Kansas. No. 1246 of the collection of Prof. F. H. Snow; E. P. West, collector.

PHYLLITES DURESCENS, sp. nov.

Pl. LXI, Fig. 5; Pl. LXII, Fig. 3.

Leaves coriaceous, flat or incurved along the borders, broadly oval, entire, undulate, rounded at apex, narrowed to a long petiole, penninerved; midrib straight and stout, percurrent; secondaries equidistant, parallel, oblique, with few branches, craspedodrome.

These leaves are of large size, being narrowed and prolonged downward, their borders nearly entire, their long petiole straight down as continuation of the midrib and with distant parallel secondaries. They are comparable to some species of Terminalia, like *T. radobojana* Ung., of the Miocene of Europe, *T. rectinerva* Velen.,[1] which, like that of the Miocene, has the leaves narrow, but the secondaries are straight in passing toward the borders and craspedodrome. The relation which is marked in the general appearance is not really close.

The leaves are very variable in size, ranging from 6.5^{cm} in length or more, from 3.5^{cm} to 6.5^{cm} broad in the middle, the larger leaves having the petiole like a continuation of the midrib 3^{cm} long, inflated at the point of attachment. They have six pairs of strong, alternate, oblique secondaries diverging 40° to 45° from the midrib, according to the width of the leaves, and passing straight to the borders with few branches.

Habitat: Probably all Ellsworth County, Kansas. Fig. 3, Pl. LXXIV, is No. 2749 of the U. S. National Museum.

[1] Fl. Böhm. Kreide., pt. 3, Pl. V, Figs. 1, 2.

PHYLLITES INNECTENS, sp. nov.
Pl. LXV, Fig. 6.

Leaf small, lanceolate, obtuse, enlarged above the base or bossed on one side, apparently clasping by the base (destroyed); midrib conspicuous, percurrent; secondaries few, very thin, oblique at base, arched, camptodrome, distant, forming large festoons near the borders.

A fragment of peculiar form but not quite determinable, the base being destroyed. It is 3.5^{cm} long, obtuse, enlarged above the base to 1.5^{cm} in width, bossed on one side, inflexed on the other. No analogy recognized.

Habitat: Ellsworth County, Kansas. No. 1143 of the collection of Mr. R. D. Lacoe.

PHYLLITES RHOIFOLIUS Lesq.

Cret. Fl., p. 111, Pl. XXII, Figs. 5, 6.

PHYLLITES RHOMBOIDEUS Lesq.

Cret. Fl., p. 112, Pl. VI, Fig. 8.

PHYLLITES UMBONATUS Lesq.

Cret. Fl., p. 113, Pl. XIX, Fig. 4.

Apparently a small, deformed, and fragmentary leaf of *Liriophyllum populoides* Lesq. (Cret. and Tert. Fl., p. 76, Pl. XI, Figs. 1, 2).

PHYLLITES AMORPHUS Lesq.

Cret. Fl., p. 113, Pl. XXII, Figs. 3, 4.

PTENOSTROBUS NEBRASCENSIS Lesq.

Cret. Fl., p. 114, Pl. XXIV, Fig. 1.

NORDENSKIÖLDIA BOREALIS Heer.
Pl. XLIV, Fig. 6.

Fl. Foss. Arct., vol. 2, pt. 3, p. 65, Pl. VII, Figs. 1–13.

Fruit capsular, dehiscent; carpels 10 to 12, woody, verticellate around a central axis; seeds small, ovate.

Under this name and as described above, Heer has figured a large number of globose, capsular fruits, to which the one figured here is apparently referable. I have seen only two specimens of these fruits from the Dakota Group, both partly embedded in a hard, ferruginous sandstone and closed, except the upper part of the one figured here, which is partly broken.

It is composed of about twelve divisions or carpels placed around a central axis. Of the numerous figures of Heer (loc. cit.), it essentially resembles Figs. 2c and 10a, being only a little larger. But Heer[1] acknowledges as representing the same species, fragments of still larger seed than the one I have figured. He considered it first as a fruit of Diospyros. He compares the fruits to those of Abeibopsis, described in Fl. Tert. Helv., vol. 3, Pl. CXVIII, and also to those of *Cucumites variabilis* Bowerb., from the London clay. The relation of these fruits to Nordenskiöldia may receive a higher degree of authority from the fact that fine leaves of Abeibopsis have been found in the Dakota Group as well as in an upper stage of the Cretaceous, as described below.

The identity of the species with that of Heer is not positively ascertained, though no appreciable difference is to be remarked.

Habitat: Kansas. Collection of Mr. R. D. Lacoe.

CARPITES CORDIFORMIS, sp. nov.

Pl. XXII, Fig. 9.

Fruit deeply impressed into the stone, cordiform, separated in the middle by a deep, linear furrow, as though composed of two narrowly obovate ovules, which are straight and confluent in the middle, rounded above, curved on the sides, pointed at the upper end, convex on the surface.

The fruit is 12^{mm} long and 10^{mm} broad in the upper part, and is not flattened, but each of the ovules is convex, as if connate in the middle along the narrow line of separation. It seems thus conformed like the seeds of Sapindus, comparable, for example, to *S. falcifolius* as figured by Heer in Fl. Tert. Helv., vol. 3, Pl. CXX, Fig. 8, which is, however, smaller and oval. As Heer remarks, p. 61 (loc. cit.), in some species of Sapindus, *S. saponarius* L., for example, the seeds or ovules are united by twos along a thin, linear clasp. Of the simple, detached seeds the author has also figured a number (loc. cit., Pl. CXXI, Fig. 2c), some of them rounded on one side, straight or flat on the other, of such a shape that if two of them were connate along the lineal side they would produce a fruit like that described above.

As the leaves of Sapindus are abundantly found in the Dakota Group, the reference of this fruit to that genus seems authorized.

Habitat: Kansas. No. 4111 of the collection of Mr. R. D. Lacoe.

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[1] Fl. Foss. Arct., vol. 1, Pl. XLVII, Fig. 5f; vol. 7, p. 125.

CARPITES TILIACEUS? Heer.
Pl. XXII, Figs. 6, 7.

Mioc. Balt. Fl., p. 101, Pl. xxx, Figs. 42, 43.

Fruit globose, with five carpels; carpels woody, verticellate.

This round, small seed, as represented in Fig. 6, is similar to that described and figured by Heer (loc. cit.). The identification is, however, very uncertain, like that of those rare fossil fruits as yet found in the shale of the Dakota Group. I consider Fig. 7 as a crushed fragmentary part of the same species.

Habitat: Kansas. In the collection of Mr. R. D. Lacoe.

CARPITES CONIGER, sp. nov.
Pl. XXXVIII, Fig. 17.

Seed round-conical, rounded at base, 5^{mm} long, and as large in the middle. Relation unknown.

Habitat: Ellsworth County, Kansas. No. 832 of the collection of the museum of the University of Kansas. Collected by E. P. West.

CARPITES OBOVATUS, sp. nov.
Pl. LXII, Fig. 5.

Fruit, hard, subglobose or lenticular, 4^{mm} long, 4^{mm} broad, subcuneate at the upper slightly broader end, covered with a thick, leathery pulverulent surface.

It is comparable to some fruits of the Laurineæ. It is also like, but a little smaller than, that figured by Heer without name or remark in the Miocene Balt. Fl., Pl. xxii, Figs. 18 and 19. It is half imbedded in a piece of ferruginous sandstone and not accompanied by remains of leaves.

Habitat: Ellsworth County, Kansas. No. 1190a of the museum of the University of Kansas; E. P. West, collector.

CARPITES? sp. Lesq.

***Carpolithes?* Lesq., Cret. Fl., p. 114, Pl. xxvii, Fig. 5; Pl. xxx, Fig. 11.**

CALYCITES sp.
Pl. XXII, Fig. 8.

Apparently a deformed calyx, with linear, short divisions. No relation known to it.

Habitat: Kansas. In the collection of Mr. R. D. Lacoe.

TABLE OF DISTRIBUTION.

Table showing the distribution of plants of the Dakota Group.

Species of the Dakota Group that also occur in other formations.	Sweden.	North Persia (Albours).	Bavaria.	China.	India (Rajmahal Hills).	Austria.	England (Yorkshire, etc.).	Eastern Siberia (Ust Balei, etc.).	Spitzbergen (Cape Boheman).	Japan.	India (Jabalpur Group).	Ipswich, Queensland.	Cape Staratchin and Green Harbor.	Potomac.	Kootanie of British Northwest Territory.	Cape Lisburne, Alaska.	Westphalia.	Greenland (Kome beds).	Austrian Silesia.
FORMATIONS IN WHICH SPECIES OF THE DAKOTA GROUP ARE ALSO FOUND.																			
	Triassic.			Jurassic.										Cretaceous.					
	Rhetic.			Rhetic or Lias.	Lias.		Oolite.							Potomac.	Neocomian.			Urgonian.	
Asplenium Dicksonianum Heer															×	×		×	
Gleichenia Kurriana Heer															×			×	
Nordenskiöldi Heer														×				×	
Podozamites angustifolius Schimp	×							×	×										
lanceolatus Schimp	×	×	×	×	×	×	×		×	×	×	×							
Pinus Quenstedti Heer													×				×		×
Phyllocladus subintegrifolius Lx																			
Sequoia Reichenbachi Gein													×	×	×			×	×
fastigiata Heer													×					×	
condita Lx																			
Glyptostrobus gracillimus Lx															×				
Populus Berggreni Heer																			
hyperborea Heer																			
Stygia Heer																			
Quercus (Dryophyllum) hieracifolia Hos. u. v. Mark																			
Myrica emarginata Heer																			
longa Heer															×				
Juglans arctica Heer																			
crassipes Heer																			
Platanus Heerii Lx															×				
Liquidambar integrifolium Lx																			
Ficus crassipes Heer																			
Krausiana Heer																			
lanceolato-acuminata Ett																			
Artocarpidium cretaceum Ett															×				

Table showing the distribution of plants of the Dakota Group—Continued.

Species of the Dakota Group that also occur in other formations.	Formations in which species of the Dakota Group are also found.																			
	Triassic.			Jurassic.										Cretaceous.						
	Rhetic.			Rhetic or Lias.	Lias.		Oolite.							Potomac.	Neocomian.			Urgonian.	
	Sweden.	North Persia (Albours).	Bavaria.	China.	India (Rajmahal Hills).	Austria.	England (Yorkshire, etc.).	Eastern Siberia (Ust Balei, etc.).	Spitzbergen (Cape Boheman).	Japan.	India (Jabalpur Group).	Ipswich, Queensland.	Cape Staratchin and Green Harbor.	Potomac.	Kootanie of British Northwest Territory.	Cape Lisburne, Alaska.	Westphalia.	Greenland (Kome beds).	Austrian Silesia.
Proteoides daphnogenoides Heer																			
lancifolius Heer																			
Laurus plutonia Heer																			
nebrascensis Lx																			
Hollæ Heer																			
angusta Heer																			
Sassafras acutilobum Lx																			
recurvatum Lx																			
Cinnamomum Scheuchzeri Heer																			
Heerii Lx																			
ellipsoideum Sap. & Mar																			
sezannense Wat																			
Diospyros primæva Heer																			
Steenstrupi ? Hos																			
Andromeda Parlatorii Heer																			
Pfaffiana Heer																			
affinis Lx																			
Hedera ovalis Lx															×				
Aralia formosa Heer																			
grœnlandica Heer																			
Eucalyptus Geinitzii Heer																			
Callistemophyllum Heerii Ett																			
Colutea primordialis Heer																			
Leguminosites coronilloides ? Heer																			
insularis Heer																			
phaseolites ? Heer																			
Sapindus Morrisoni Lx																			
Cissites formosus Heer																			
Paliurus ovalis Dn															×				
Ilex borealis Heer																			
Protophyllum Leconteanum Lx															×				
Macclintockia cretacea Heer															×				
Magnolia amplifolia Heer																			
alternans Heer																			
obtusata Heer																			
speciosa Heer																			
Capellinii Heer																			
Liriodendron primævum Newb																			
Meekii Heer																			
Phyllites Vanonæ Heer																			
Nordenskiöldia borealis Heer																			

Table showing the distribution of plants of the Dakota Group—**Continued.**

Species of the Dakota Group that also occur in other formations.	FORMATIONS IN WHICH SPECIES OF THE DAKOTA GROUP ARE ALSO FOUND.																	
	Cretaceous.														Tertiary.			
	Cenomanian.								Senonian.									
	Greenland (Atane beds).	Bohemia, (Perutz, etc.).	Moravia (Moletein).	Silesia.	France.	Saxony (Niederschoena, etc.).	Amboy clay.	Turonian.	Prussian Saxony (Quedlinberg, etc.).	Westphalia.	Tyrol (Brandenburg).	Greenland (Patoot beds).	Laramie.	Bozeman, Mont., coal field.	Eocene.	Oligocene.	Miocene.	Pliocene.
Asplenium Dicksonianum Heer	×																	
Gleichenia Kurriana Heer		×	×						×									
Nordenskiöldi, Heer																		
Podozamites angustifolius Schimp																		
lanceolatus Schimp																		
Pinus Quenstedti, Heer	×		×	×														
Phyllocladus subintegrifolius Lx	×													×				
Sequoia Reichenbachi Gein	×	×	×		×	×	×		×	×	×		×	×				
fastigiata Heer	×	×	×		×	×						×						
condita Lx							×											
Glyptostrobus gracilimus Lx							×											
Populus Berggreni Heer	×						×					×						
hyperborea Heer	×											×						
Stygia Heer	×											×						
Quercus (Dryophyllum) hieracifolia Hos. u. v. Mark	×									×								
Myrica emarginata Heer	×																	
longa Heer	×					×												
Juglans arctica Heer	×																	
crassipes Heer			×									×						
Platanus Heerii Lx	×						×						×					
Liquidambar integrifolium Lx																		
Ficus crassipes Heer	×																	
Krausiana Heer	×		×															
lanceolato-acuminata Ett																		
Artocarpidium cretaceum Ett						×												
Proteoides daphnogenioides Heer							×											
lancifolius Heer									×									
Laurus plutonia Heer	×	×										×						
nebrascensis Lx							×											
Hollæ Heer	×											×						
angusta Heer	×											×						
Sassafras acutilobum Lx		×																
recurvatum Lx	×																	
Cinnamomum Scheuchzeri Heer													×	×	×	×	×	×
Heerii Lx							×							×		×		
ellipsoideum Sap. & Mar												×			×			
sezannense Wat	×											×			×	×		
Diospyros primæva Heer	×											×						
Steenstrupi Hos	×											×						

Table showing the distribution of plants of the Dakota Group—Continued.

Species of the Dakota Group that also occur in other formations.	FORMATIONS IN WHICH SPECIES OF THE DAKOTA GROUP ARE ALSO FOUND.																
	Cretaceous.													Tertiary.			
	Cenomanian.								Senonian.								
	Greenland (Atane beds).	Bohemia (Perutz, etc.).	Moravia (Moletein).	Silesia	France.	Saxony (Niederschoena, etc.).	Amboy clay.	Turonian.	Prussian Saxony (Quedlinberg, etc.).	Westphalia.	Tyrol (Brandenburg).	Greenland (Patoot beds).	Laramie.	Bozeman, Mont., coal field.	Eocene.	Oligocene.	Miocene.	Pliocene.
Andromeda Parlatorii Heer	×						×							×				
Pfaffiana Heer	×																	
affinis Lx														×				
Hedera ovalis Lx																		
Aralia formosa Heer		×	×															
grœnlandica Heer	×																	
Eucalyptus Geinitzii Heer	×	×	×															
Callistemophyllum Heerii Ett						×												
Colutea primordialis Heer	×																	
Leguminosites coronilloides ? Heer	×																	
insularis Heer	×																	
phaseolites ? Heer	×						×											
Sapindus Morrisoni Lx	×											×						
Cissites formosus Heer	×																	
Paliurus ovalis Dn																		
Ilex borealis Heer												×						
Protophyllum Leconteanum Lx																		
Macclintockia cretacea Heer												×						
Magnolia amplifolia Heer		×	×															
alternans Heer	×						×							×				
obtusata Heer	×																	
speciosa Heer		×	×															
Capellinii Heer	×	×					×											
Liriodendron primævum Newb	×											×						
Meekii Heer	×											×		×?				
Phyllites Vanonæ Heer	×																	
Nordenskiöldia borealis Heer	×																	

ANALYSIS OF THE DAKOTA GROUP FLORA.

The Flora of the Dakota Group, as far as it is known to the present time, is composed of 460 species, of which 6 are Ferns, 12 Cycads, 15 Conifers, 8 Monocotyledons, and 429 Dicotyledons; while that of the schists of Atane, from which 274 species are known, has 31 Ferns, 8 Cycads, 27 Conifers, 8 Monocotyledons, and 197 species of dicotyledonous plants, mostly represented by leaves. The diversity in the number of Ferns and Conifers in these floras is very striking and seems at first to disprove their reference to the same age. But that disparity is merely illusive and largely due to local circumstances (to be further examined), for really, except in the Ferns and the Conifers, there is little difference in the composition of the two floras. That of Atane has 11 per cent in Ferns, while that of the Dakota Group has only $1\frac{3}{10}$ per cent, with $3\frac{1}{2}$ per cent of Conifers against 10 per cent in Atane; the Cycads are $2\frac{3}{5}$ per cent of the vegetation in the Dakota Group and 3 per cent in that of Atane, while the monocotyledonous plants were slightly more predominant at Atane, and the Dicotyledons form 91 per cent of the Dakota Group flora and 72 per cent of that of Atane.

In considering the relative distribution of the dicotyledonous plants on which we have essentially to rely in looking for the degree of relationship of the floras, we find all the essential divisions and genera of plants represented in the flora of the Dakota Group and in that of the schists of Atane, and among them a large number of species identical in both.

First, the Apetalæ have in both species of Myrica, Betula, Quercus, Populus, Platanus, Ficus, Proteoides, Lomatia, Laurus, Sassafras, and Cinnamomum; the Gamopetalæ have in both species of Diospyros and Andromeda; the Polypetalæ have species of Aralia, Hedera, Cissites, Cornus, Magnolia, Liriodendron, Menispermites, Sterculia, Apeibopsis, Sapindus, Celastrophyllum, Ilex, Rhamus, Juglans, Rhus, Eucalyptus, and some Leguminosæ. Of the genera represented in the Flora of the Dakota Group and not in that of Atane, the most important is Salix, of which abundant remains of leaves and a fruiting catkin have been found in Kansas and Nebraska, having been described by Heer, Newberry, and myself; Persea, which counts little by its absence, as the leaves of related species of the Laurineæ, indifferently referred to Laurus or Persea; Aristolochia, one species of which is described by Heer from a single leaf in the *Phyllites Crétacées du Nebraska;* Viburnum, Acer, Elæodendron and Cratægus, which may belong to more recent types, as they have representatives in the Cretaceous of Patoot; Hamamelites, Paliurus and Zizyphus, of which the few species observed belong to the Dakota Group, and are also represented at Patoot. The genus Protophyllum, which is remarkably abundant in the Dakota Group, takes there the place of Credneria, whose remains are so characteristic of the Cenomanian of Germany. From the schists of Atane, Heer has described as Credneria a single poorly preserved leaf, possibly referable to a peculiar genus derived from Protophyllum, but he has not described species of Protophyllum. Of the number of species identified in both the flora of the schists of Atane and that of the Dakota Group, we have in the ferns one only, *Asplenium Dicksonianum* Heer, which was first described from the Lower Cretaceous of Kome. In the Cycads nearly the same number of species are recorded in each flora, but none are identical. Of the Conifers, four are identical, and in the dicotyledonous series there are identified two species of Myrica, one of Quercus, three of Populus, one of Platanus, two of Ficus, three of Laurus, one of Cinnamomum, one of Sassafras, two of Diospyros, two of Andromeda, one of Cissites, three of Magnolia, two of Liriodendron, one of Juglans, and four of Leguminosæ, making in all thirty-four species, or about the one-fourteenth part of the whole number of species described from the Dakota Group. The proofs of the synchronism are really conclusive. For if we consider the distance between the localities, which are separated by at least 35° of latitude, and consequently the probable difference in the atmospheric circumstances, with its bearing upon the vegetation, the nature of the ground, etc., the relation of the floras appears far more distinctly marked than is general between two groups of plants of the same geologic age; the Miocene, for example, represented by unlike species even at localities merely a few miles distant from each other. But how can we explain the predominance of the Ferns and Conifers in the Flora of Atane and the scantiness of plants of this kind in that of the Dakota Group? Atmospheric humidity governs the land vegetation in its nature and distribution. By its degree it regulates the climate and the seasons. At the present epoch this generally known fact is evidenced in the peculiar character and habitat of some groups of plants, the Ferns and Conifers especially, which generally thrive upon moist or shady ground, or upon the slopes or the summits of mountains bathed by the clouds, or along shores where they are constantly or periodically moistened by the misty winds of the ocean. In the older geological times the earth, whose heated crust by contact with water caused constant and prodigious vaporization, was surrounded by a thick vail of vapors impenetrable to the rays of the sun. This rendered the climatic conditions unalterable, not only locally but over the whole surface of the globe. Hence the uniformity and peculiar character of the vegetation of the Devonian and Carboniferous ages, composed, as they are, of semi-aquatic or amphibious woody plants of gigantic size, such as Ferns and Lycopods. In the floras of the subsequent ages, first the Permian for example, the Conifers gradually become more abundant; then in the Triassic and Jurassic the Cycads increase in the number of their representatives, and thus the vegetation shows only the slow and gradual modification of some of its predominant groups. But until the beginning of the Cretaceous, the variations relate to certain specific or generic forms, but do not affect the general character of the vegetation of the world, being still under the influence of a superabundant atmospheric humidity. The vegetable remains are always Acrogens, the Ferns especially being the predominant and less diversified component of the ancient floras, with the Conifers and the Cycads next in order. And even in the Wealden, which closes the Jurassic period, the plants, as far as they are known by fossil remains, are still referable to the same groups of plants as those of the Jurassic. It is only from the base of the Cretaceous that the vegetable remains show by certain characters a marked diminution in the influence of atmospheric humidity. Then the thickened crust of the earth had gradually become more cooled; the misty atmosphere was clearer and allowed the rays of the sun to penetrate and act directly upon the surface of the earth, which served to bring out local or periodical alterations of climates, conditions, and seasons, and thus to force under this new influence and by its action important changes in the nature and aspect of the vegetation of the world, first by the introduction of the Monocotyledons and soon after by that of Dicotyledons.

Perhaps, from the presence of one monocotyledonous species in the flora of the Wernsdorf shale (Neocomian) and one of dicotydonous leaf and of five Monocotyledons in the formation of Kome (Urgonian), from the great decrease in the numbers of Cryptogams and Conifers and the prodigious multiplication of Dicotyledons in the schists of Atane (Cenomanian) immediately superposed upon those of Kome, and in the formation of the

Dakota Group, we have an indication of the gradual march and development of the vegetation, and are enabled to refer the origin of the dicotyledonous plants to the beginning of the Cretaceous period. For the leaves of Populus recognized in the Kome schists, though the first observed fossil remains of a dicotyledonous plant, probably do not represent the species of that class of vegetation first produced. The active influences producing gradual modifications must have existed for long periods before definite results could be recognized by naturalists in the remains of a dicotyledonous flora. We can not, therefore, expect to discover and recognize the first representative of the new race, that of the Dicotyledons; but some valuable conclusions on the nature and subsequent distribution of this new vegetable group may be derived from studying the peculiar character of some of the leaves of the Cenomanian. In looking over the leaves of the Dakota Group, which, in a flora of 460 species, represent 429 Dicotyledons, one can but wonder at the work of nature which, in apparently so short a period, has produced such an immense diversity of specific forms of leaves. The word "specific" may seem hazardous. But it will suffice to examine the character of a few of the leaves of the Dakota Group, to recognize not merely their prodigious disposition to vary, but, at the same time, to effect such great modifications in character that the result of the variations has often to be admitted as implying not merely specific but generic differences as well.

Considering the leaves of Liriodendron, for example, we find them entire, ovate or oblong, always truncate or emarginate at the apex. In *Liriodendron primævum* Newb. (Pl. XXVI, Figs. 1–4), with its synonyms, *Leguminosites Marcouanus* Heer and *Phyllites obcordatus* Heer are considered by Heer as varieties of *L. Meekii.* It is the true original form named again *L. simplex* by Newberry, in bulletin of the Torrey Botanical Club, January, 1887. The base of the leaf enlarges, as shown in Fig. 2, but the specific relation is still preserved. Gradually the leaves become more enlarged, rounded, broadly, distinctly lobed on each side in the lower part, but remaining ovate, obtuse or obtusely pointed, instead of emarginate at apex, clearly representing a new species, *L. semialatum* (Pl. XXV, Figs. 2–4; Pl. XXIX, Fig. 3). Then, as seen in Pl. XXVIII, Figs. 5, 6, the leaves become constricted in the middle, deeply emarginate at apex, and finally fiddle-shaped or bilobate on each side in *L. Meekii* Heer. Still preserving a closely allied form, but being greatly enlarged, with lobes at right angles or oblique, the leaves represent the remarkable *L. giganteum,* which is the Cretaceous type of which the Tertiary, *L. Procaccinii,* and the living *L. tulipifera* are representatives. This species is figured in Pl. XXV, Fig. 1; Pl. XXVI, Fig. 5, and Pl. XXVII, Fig. 1, and its variety *cruciformis* in Pl. XXVIII, Figs. 1, 2. From it is derived *L. intermedium*, a species with large leaves, narrowly bilobate on each side, deeply emarginate at apex distinguished by the oblique direction of the upper lobes, which are far distant from the lower, as shown in Pl. XXV, Figs. 2, 3, and by the forking or the division of the lower lobes, the variety *bilobata* (Pl. XXVIII, Fig. 4). Then by the upper lateral lobes, which are simple, linear, obtuse, and ascending in an acute angle of divergence, while the lower ones, curving upward, reach nearly as high as the top of the upper, the leaves take a peculiar appearance, like that of some species of Aralia as seen in *L. Wellingtonii* (Pl. XXVIII, Fig. 3). And now another peculiar mode of division is observable in the leaves of the genus. They become alternately cut into a number of lateral lobes, either short, round, obtuse, or truncate at the sides, as in Pl. XXVII, Figs. 4, 5, which is *L. pinnatifidum*; or they have the lobes cut not merely to the middle of the lamina, as in the last species, but throughout to the median nerve, and are narrower, being long, linear or rather slightly enlarged from the base to the rounded or obtusely lobate apex, parallel and equidistant at base, appearing like leaflets of a compound leaf, as seen in *L. Snowii* (Pl. XXIX, Figs. 1, 2).[1] Add to these remarkable specific forms those described by Dr. Newberry in bulletin of the Torrey Botanical Club, January, 1887, as *Liriodendron oblongifolium* and *L. quercifolium*, leaves which are oval, bordered with long, sharp teeth, and resembling oak leaves; then the leaves described as *L. obcordatum*, this volume (Pl. XXVIII, Fig. 7), and again, those of *L. Beckwithii* and *L. populoides* Lesq. (Cret. and Tert. Fl., Pl. x, Fig. 1; Pl. xi, Figs. 1, 2), and from the whole series of forms there are evidently represented twelve well defined species with marked varieties, and from this we may get an idea of the extraordinary variability of the leaves of Liriodendron, at or near the origin of that genus, or nearly, as far as we know, of the first appearance of dicotyledonous plants.

In the leaves legitimately referred to Sassafras by their peculiar characters, and by the presence of fruits found with them in the same strata, we have those of *S. Mudgei* and *S. acutilobum* Lesq. (Cret. Fl., Pl. xix), all trilobate with entire lobes. In *S. cretaceum* (loc. cit., Pl. xi, Fig. 1), the leaves, which are also trilobate, have the borders of the lateral lobes slightly

[1] The figures of this species of Liriodendron are much like that of Artocarpus, sp. nov., in Zittel's Handbuch d. Paleontologie, vol. 2, p. 478, fig. 5, which represents a leaf discovered in the Cretaceous of Greenland by Prof. Nathorst. Generic difference is shown by the nervation and the emarginate apex.

dentate, a character which is not remarked in any of the Laurineæ of the present epoch.

But these leaves are very similar to those of the living *Sassafras officinale* Nees., showing much the same disposition to remain entire, or merely lobed on one side, as in *S. subintegrifolium*, Pl. XIV, Fig. 2, of this work, that one can but consider them as original representatives of the genus. Moreover, a number of specimens of the same kind were found heaped together as though derived from the same tree, which apparently bore some leaves with borders entire, and others having leaves with the borders mere or less deeply dentate. Then *S. mirabile* Lesq. (Cret. Fl., Pl. XII, Fig. 1) is founded upon trilobate leaves of the same shape as those of *S. cretaceum*, but more distinctly dentate and so large that they were originally referred to Platanus. And this analogy of characters or double affinity is recognized as well in *Platanus recurvata* Lesq. (Cret. Fl., Pl. X, Figs. 4, 5), while some of the characters of Cissus or Cissites are seen in the leaves of *S. harkerianus* Lesq. (loc. cit., Pl. XI), and those of Aralia in the species of Sassafras (Araliopsis), a subdivision necessarily admitted to indicate the double or multiple characters of a number of leaves of the Dakota Group. Even this dualism of generic names is not sufficient to point out and clearly indicate the generic relationship of some of these leaves. Is *Sassafras (Araliopsis) platanoides* Lesq. (Cret. and Tert. Fl., Pl. VII, Fig. 1) referable to Sassafras, to Aralia, or to Platanus? The splendid leaf of *Sassafras (Araliopsis) dissectum* (Pl. XIV, Fig. 1, of this volume) has, in the divisions of the lateral lobes, the character of Aralia, while by the size and the general outline it is a Platanus, and still further by the basilar prolongation and the dentate lobes it is merely a variation of *Sassafras mirabile.* In these leaves the transformation has merely acted upon the division of the lobes, the base, in all the modifications, remaining prolonged downward in narrowing and decurring to the petiole. But the metamorphosis further passes to the base, which becomes rounded peltate and traversed by the petiole, as in *Aspidiophyllum trilobatum* Lesq. (Cret. and Tert. Fl., Pl. XIII), and takes a new character allying it to that of some leaves of Menispermites. Nevertheless, Aspidiophyllum leaves are, by their upper trilobate part and entire lobes, so like those of Sassafras that the specimens found deprived of the basilar portion of the leaves have generally been referred to this last genus. And now what is *Aspidiophyllum dentatum* (Pl. XXXIX, Fig. 1, this volume)? It is a distinctly trilobate leaf with bilobate and obtusely dentate lobes like *Sassafras dissectum*, the base first contracted or strangled and then enlarged into a round dentate pelta, traversed by the petiole. It is a leaf of Aspidiophyllum by the general outline and the contracted base, while the basilar appendage or pelta is like a primordial form of the stipules, as in *Platanus basilobata* Ward, of the Laramie Group, *P. appendiculata* Lesq., of the auriferous gravel formation of California, and definitively in *P. occidentalis* of the living flora. The leaves of this last species preserve mostly the characters already remarked in those of the Dakota Group and described as belonging to *Platanus primæva*, though the first specimen described (Lesquereux, Cret. Fl., Pl. vii, Fig. 2) was only a mere fragment, and has in its outlines some likeness to Credneria. Now we have in Pl. VIII, together with an entirely preserved leaf of the same type, a raceme of flowers evidently warranting its reference to Platanus, and in Pl. IX two varieties of leaves equally distinctly dentate like those of *P. aceroides* of the Miocene, and of the living *P. occidentalis*. The same remark on the variability of the leaves of the Dakota Group might be made in comparing the forms and characters of those which have been described as Aralia, Sterculia, Cissites, Menispermites, Protophyllum, etc. The transformations, however, are not always so distinct or so widely different. In *Acerites multiformis* (Pl. XXXIV, Figs. 1–9), for example, if we compare the extreme forms, that of Fig. 1 and Fig. 4, the leaves seem to represent two well characterized species. But in pursuing the comparison through the intermediate forms, one can not say where to break the chain of relation for the introduction of a new species. The leaves in this case evidently show a disposition to metamorphosis, but it is limited to a certain degree or to gradual modifications, comparable indeed to what is observed sometimes at our epoch among the leaves of a single tree.

It is difficult to understand what influences have acted upon the plants of the Cretaceous in producing the transformation recognized in the appearance of the first dicotyledonous leaf. But it is rational to admit that this influence, once in activity, has been continued and has rapidly multiplied and diversified the organization of the first representatives of the Dicotyledons.

But how is it that, though the vegetable types are so easily and so diversely modified near their origin, that the essential characters of many of them remain persistent and may be recognized in the plants of more recent periods, being there traced by their generic representatives and even recognized in the flora of the present epoch? I have already asserted that most of the types of the arborescent flora of North America were present in that of the Dakota Group, and that most of them had left remains of allied specific or generic forms in the intermediate periods. In support of the assertion I may be excused for briefly reviewing the distribution of the more important types of the flora of the Dakota Group as far as they are recognized in the succeeding formations.

The Myricaceæ have only the genus Myrica, which is represented by nineteen species in the flora of the Dakota Group, two of which are identified in the schists of Atane, one of these passing also to the Upper Cretaceous stage of Patoot. Of the species of the Dakota Group *Myrica emarginata* Heer, recognized at Atane and Patoot, has its relation to *M. salicina* of the Miocene; another, *M. aspera* Lesq., is the type of *M. cerifera* Linn., the bayberry or wax myrtle now inhabiting the sea and lake shores of the United States; *M. Sternbergii* has its affinity to a species found at Sézanne. Leaves of Myrica of coriaceous texture, having the nervation more or less obscured by immersion in the thick parenchyma, are generally of difficult determination, and their generic references therefore remain doubtful in some cases for a long time. *Myrica longa* Heer, for example, was first placed in the Proteaceæ. Now, a large number of well preserved leaves have been recognized by their nervation as truly referable to this genus, whose presence in the Cenomanian flora is confirmed by seeds and scales of catkins abundantly found in the shale of the Dakota Group. *Myrica Torreyi* Lesq., a species also recognized in the Laramie Group, has remarkably fine and distinctly characterized leaves. As yet its affiliation with Cretaceous types is not known. Schimper mentions its relation to *M. longifolia* Sap., of the Oligocene of France, and this, like *M. Græffii* Heer, is closely allied to the living *M. californica* Cham.

A large number of small leaves, very finely preserved in concretions, have lately been collected in Kansas. Considering their essential characters, the form and nervation of the leaves, I regard them as related to Betula, and have described them under the name of Betulites. Saporta, to whom a number of specimens have been sent, is disposed to refer them to Viburnum. The leaves, as mentioned in the descriptions, have the same facies and the same characters as those of our living *Betula nigra*, and I am the more disposed to admit them as the original representatives of the genus, since three species of Betula are recognized by Heer in the Senonian flora of Patoot, in leaves that are all remarkably similar in form, size, nervation, and even in the peculiar dentation of their borders, to those of the Dakota Group. The same remarkable analogy of characters is observable, especially in *Betula coryloides* Ward, of the Laramie flora, and henceforth in numerous species of the Tertiary, which are more or less closely allied to those of the present flora of North America. Besides the three species described by Prof. Ward from the Laramie, one other has been described from Golden, two from the Green River Group, four from the Miocene of Alaska and Oregon, and one from the auriferous gravel deposits (Upper Miocene or Pliocene) of California. In all these species the original type, represented in the numerous figures of leaves of Betulites, this volume (Pl. IV and Pl. V), is more or less discernible, as well as in some of the eight species, all of wide distribution, which are still living in North America. The only living species exclusively pertaining to the flora of California, *B. occidentalis* Hook., has its ancestor in *B. æqualis* Lesq., of the auriferous gravel deposits of the same State.

With a less degree of evidence we may follow a gradual distribution of the species of Alnus from the Cenomanian upward. A species of Alnites is described by Dr. J. S. Newberry from specimens procured in the Dakota Group of Nebraska, and another by Sir William Dawson from the Milk River series of Canada. A species more cleary defined, *Alnus protogæa* Heer, is from Patoot. Then we have another from the Laramie, three from the Green River Group, and four from the Miocene of Alaska and Oregon. Among the last, *A. Kefersteinii* is the most common species of the Miocene of Europe as well as of America. Of the six species of Alnus now living in the United States the relation of *A. incana* Willd., especially the variety *virescens*, common along the mountain streams from Colorado westward, is clearly marked with *A. Kefersteinii*, while that of *A. maritima* Nutt., of the Atlantic States, is still more evident with *A. corallina* Lesq., of the Miocene of Oregon.

In the Cupuliferæ a large number of vegetable remains of the Dakota Group, especially leaves, are referred to Quercus or Dryophyllum. The leaves are generally determined by distinct characters, which are easily followed in their various modifications through geologic time. Of eighteen species of Quercus, seven of the subdivision Dryophyllum are described from the Dakota Group. Heer has six species from the schists of Atane and eight from the Senonian of Patoot. Of these, *Q. hieracifolia* Hos., of the Senonian of Westphalia, is present in the schists of Atane, in the Dakota Group, and in the flora of Patoot; *Quercus hexagona* Lesq. is reproduced in *Q. troglodites* Heer, of the Senon of Atanekerdluk. In the specimens obtained by the scientific expedition of Princeton, which I consider as referable to the

Senonian, I have found nine species of Quercus, among them five of Dryophyllum, all more or less closely related to species of the Senonian of Belgium and Westphalia; then Dawson describes *Quercus Victoriæ*, from Vancouver Island, and I have recorded three species more from the specimens collected by Dr. Evans in the same locality. This gives us forty species of Quercus already known from the North American Cretaceous, without counting those in Dr. Evans's collection, the descriptions of which have never been published. We have besides two species of Fagus from the Dakota Group and one from the Milk River series of Canada, described by Dawson. From different stages of the Laramie Group, Prof. Ward has four species of Quercus and as many of Dryophyllum, while I have described from localities referable to the Laramie Group ten species of Quercus, four of which pertain also to the Miocene of Europe, and two of Dryophyllum. We have, besides, from the Green River Group eight species of Quercus, one only exclusively American, one of Fagus, and one of Castanea. Then from Miocene formations of Alaska, Oregon, the auriferous gravel deposits or chalk bluffs of California, four species of Fagus, three of Castanea, and twenty-five species of Quercus are recorded.

On these described vegetable remains it will be remarked that the affiliation of the divers types observable in the oaks of North America, is recognized from the Cenomanian upwards, in a number of species. For example, the Chestnut oaks in *Q. primordialis* and *Q. latifolia* of the Dakota Group; *Quercus Rinkiana* Heer, *Q. Warningiana* Heer, *Q. thulensis* Heer, of the schists of Atane, while the section of the Salicifoliæ of Schimper, to which belong the willow and laurel oaks, is represented also in the Dakota Group by *Q. ellsworthiana*, the beautiful *Q. Wardiana* Lesq., with *Q. salicifolia* Newb., all types reproduced by numerous species in the Upper Cretaceous of Patoot, of Wyoming, of Vancouver Island, and still more by abundant forms in the Laramie flora and the different stages of the North American Tertiary. The only types of our living oaks, the most generally represented now in the eastern slope of the United States, is not yet recognized in the Dakota Group, and indeed has not been seen in the Cretaceous. It is that of the white and water oaks with sinuate, lobate, or deeply cut lobate leaves. Its first representatives are seen in the Laramie flora, in *Q. bicornis* Ward, and *Q. angustiloba* Al. Br. This last species, which is found at Golden, is also identified from the Miocene of Europe. In the Miocene of North America the leaves, diversely and deeply lobate, are still rare. The fine *Q. pseudolyrata* Lesq. has been figured in the flora of the auriferous gravels of California, from specimens doubtfully referable to the Upper Miocene of that locality. It is represented by numerous specimens in the collection of the U. S. National Museum from John Day Valley, Oregon. Heer has not found remains of Fagus in the schists of Atane nor in those of Patoot, nor have any been observed in the Laramie Group. The distribution of the beech, judging from its fossil leaves, is remarkable. That the genus was already present in the middle Cenomanian of North America is proved, not only by the leaves of two species described from the Dakota Group, leaves which are positively identified by the peculiar nervation which characterize those of the genus, but also by a fruit figured by Dawson from the Milk River series of Canada, and also by a species described by Ettingshausen from the Cenomanian of Niederschoena, *F. prisca*, the leaves of which have the same characteristic nervation as those of the Dakota Group. In Europe, as in North America, no traces of leaves of Fagus are recorded between the Cenomanian and the middle Tertiary. From North America one species has been recorded from the Green River Group and five from the Miocene. The species in more recent floras gradually become more closely allied to the common American beech, until we find in the Pliocene or Upper Miocene of the auriferous gravel deposits of California the leaves of *F. Feroniæ* Ung., and of *F. pseudo-ferruginea* Lesq., which scarcely differ from those of the living, indigenous *F. ferruginea* Ait.

Of the Salicineæ, the genus Salix (willow) is, as far as known now, represented in the flora of the Dakota Group by numerous leaves, some of them with obsolete nervation, whose determination is not positive; some others, like *S. nervillosa* Heer, *S. deleta* Lesq., whose relation to species of the present flora is not clear; and by others still, like *S. proteæfolia*, as figured in Lesq., Cret. and Tert. Fl., Pl. I, Figs. 14–16, distinctly characterized as leaves of Salix by their form and nervation, and still further by a finely preserved fruiting catkin, described and figured in this memoir (Pl. VIII, Fig. 6). Therefore, the presence of the genus in the Cenomanian of North America can not be disputed. As in the beech, the Cretaceous origin of the willow is confirmed by the presence of one species in the flora of Quedlinburg and one in that of the Quader of Germany. It is, however, remarkable that no species of Salix has been recognized by Heer in schists of Atane and none in the Senonian of Patoot. One only is mentioned by Dawson, from the Upper Cretaceous of Vancouver Island. Higher up in the measures, one species is recorded in the Laramie flora, viz, *Salix integra*, which is common in the European Miocene, and is also found at Black

Buttes, Wyoming. The flora of the Green River Group has five species; that of the Miocene, eight; four of them being also recorded from Alaska, the others from Oregon and California. From this it is observed that the original type, *S. proteæfolia*, is positively recognized in the Dakota Group, but that its affiliation with more recent floras is not discovered until the Miocene period is reached, where its relation is marked with *S. tenera* Al. Br., and later with a large number of the living species.

As remarked already, the first traces of dictyledonous leaves in the flora of the world were discovered by Heer in the Lower Cretaceous (Neocomian) of Kome, Greenland, in fragments of leaves of the so-called *Populus primæva* Heer. One of the leaves is preserved nearly entire, and upon the same specimen there is an involucral scale which, though entire and without hairs or cilia, apparently belongs, with the leaves, to a species of Populus. The reference, which is generally admitted, is confirmed by the number of leaves of species of Populus found in the Cenomanian. From the schists of Atane, Heer has described four species, which are also recognized in the Dakota Group with four others, three of which are described by Dr. Newberry. Three more are described as Populites from their analogy to leaves of Populus, and belong also to the Dakota Group. As far as they are now known the fossil species of Populus have been grouped in two sections according to the type of nervation of their leaves: First, leaves with two pairs of basilar primaries, the inner stronger, very oblique, curving inward in ascending; the outer or lower, shorter, generally parallel to the borders, with lowest secondaries at a great distance above the primaries, not parallel to them; second, leaves with lateral primary nerves open a nd lower secondaries about equidistant and parallel with the primaries and upper secondaries.

The first type is represented in the Dakota Group essentially by *P. elliptica* Newb. (Illustr. Cret. Tert. Pl., Pl. III, Figs. 1, 2), whose leaves are so remarkably similar in character to those of *P. arctica* Heer that this last species, which is extremely common and variable, being mostly Miocene, seems really a mere variety of the former. To the second type are referable the other species of Populus of the Cenomanian, mentioned above, with two species from Patoot, one of which is identified in the flora of Atane and in that of the Dakota Group. In the Senonian of Wyoming two species have been found, and five in the upper Cretaceous of Vancouver Island. From the Laramie Group as many as twenty-three species are recorded, among them ten new ones described by Prof. Ward in his Laramie Flora. Of the whole lot twenty are of the first type or section, which may be called *arctica*, as its first and most generally distributed species, *P. arctica* Heer, is represented in all the stages of the Tertiary, even in the small groups of plants of the auriferous gravel deposits of California, by numerous leaves of *P. Zaddachi*, its close relative. Of the second type or section the Laramie Group has only three species. From the Green River Group six species are recorded, belonging, with one exception, to the first section, and most of them already present in the Laramie; and from the ten species described as Miocene, of which seven are from Alaska and the Bad Lands, six are also referable to the first section. This section, which corresponds to that of the coriaceous poplars, has no representatives in the present North American flora.

The first leaf of the Dakota Group referred to Platanus, *P. primæva*, is described and figured in Lesq., Cret. Fl., p. 60, Pl. VII, Fig. 2. Its character, form, and nervation are distinct, and their affinity to those of *P. aceroides* Göpp., of the Miocene, and *P. occidentalis*, of the present North American flora, is easily recognized. Prof. Geinitz found in the general aspect of that leaf a likeness to Credneria leaves, but Saporta has admitted it in the *Monde des Plantes*, p. 202, Fig. 2, as the true, primitive type of Platanus. Later, as is seen in the descriptive part of this volume, numerous leaves of the same type, some of them very large, still more closely allied by their normal characters and their varieties to those of *P. occidentalis*, have been discovered, together with a flowering raceme, and thus the presence of this genus in the Dakota Group is fully confirmed. Besides the first-named species, eight others are described from specimens of the Dakota Group, two of which have been recognized in the schists of Atane in Greenland and in the Milk River series of Canada, and two in the Upper Cretaceous of Patoot. In the Upper Cretaceous plants of Wyoming and Vancouver Island no remains referable to Platanus have as yet been observed. But they have been most abundantly found in the Laramie Group, where the form of the leaves is somewhat modified in *P. Raynoldsii* Newb., *P. Haydenii* Newb., *P. nobilis* Newb., *P. rhomboidea* Lesq., and still more in *P. basilobata* Ward, the leaves of which are adorned by basilar appendages somewhat like stipules, as already remarked.

In the Laramie Group also, leaves of *P. Guillelmæ* Göpp. have been observed, and these are extremely frequent in the Miocene of Europe and North America, together with those of *P. aceroides*. *P. appendiculata* and *P. dissecta*, which is perhaps a variety of it, are so closely allied in character to those of the living *P. occidentalis*, the North American Buttonwood, that the affiliation of the genus is positively recognized from the Dakota Group, through all the more recent stages of the formations, to the present epoch.

Ficus and Morus are the only genera of the urticaceous tribe Moreæ represented in the present flora of the United States. Abundant remains of Ficus have been recognized in the geological formations from the Cenomanian upward, but none of Morus; for the two leaves described under this generic appellation by Massalongo, from the Tertiary of Italy, are still of uncertain affinity. Fruits and leaves of Ficus have also been found in the schists of Atane and still more abundantly in those of the Dakota Group.

In the description of the numerous fossil leaves referred to Ficus, Schimper separates them into two sections: First, those that are pinnately nerved; second, those that are palmately nerved. The first section has by far the largest number of representatives, as the same author refers forty-four species to it and only twenty-four to the second. Two species only of the palmately nerved leaves are represented in the Dakota Group and in the schists of Atane, one by *Ficus Hellandiana* Heer, at Atane, the other by a relative, *F. deflexa* Lesq. All the others belong to the section of pinnately nerved leaves, of which twenty are recorded in the Dakota Group flora, and two in that of Atane. In more recent geological times the second group is represented in Patoot by *F. arctica* Heer, and in the Upper Cretaceous of Wyoming (Princeton collection) by *F. deflexa*, already present in the Dakota Group, and by the beautiful *F. producta* of Montana. This last typically represents *F. pulcherrima* Sap., of the Sézanne Flora; *F. planicostata; F. pseudopopulus; F. wyomingiana* Lesq., of the Laramie; *F. Schimperi* Lesq., of the Mississippi Eocene; and is still recognized in the different stages of the Tertiary of both continents, especially in the omnipresent and most variable *F. tiliæfolia*, which is recorded from the Laramie flora, and is still represented in the Upper Miocene of the auriferous gravel deposits of California.

It would be an easy task but would take too long to follow the affiliation of the pinnately nerved leaves of Ficus from the Cenomanian to the present epoch. I may mention only the fine leaves of *F. proteoides; F. Berthoudi*, of the Dakota Group; reproduced in their essential characters, nervation, form and size of leaves, in *F. elongata* Hos.; *F. longifolia* Hos., of the Senonian of Westphalia; in *F. arenacea; F. Smithsoniana*, of the Laramie; *F. lanceolata, F. multinervis*, the beautiful *F. Ungeri*, and other species of the Green River Group; also in most of the stages of the European Miocene, etc. No species, however, of pinnately lobed leaves of Ficus is represented in more recent stages of the Tertiary of North America, where the genus seems to gradually disappear. In the flora of the auriferous gravel deposits of California, numerous leaves of *F. tilæfolia* have been found with some others described as new species, but with characters so closely allied to those of the normal form that they may represent mere varieties of it. In the Pliocene, as in the present flora, the Moreæ, forced southward by a gradual lowering of the temperature, have left the continental part of North America, remaining still present represented by three species of Ficus, which inhabit the southern end of the peninsula of Florida, while two species of Morus, recently introduced from Japan or derived from *F. tiliæfolia*, remain as beautiful trees of our forests.

The family Laurineæ is distinctly represented and easily recognized in the flora of the Dakota Group, not only by the peculiar characters, form, and nervation of the leaves, but still more by the presence of some well preserved fruits, positively referable to Laurus or another genus of Laurineæ. There have been described up to the present time, from vegetable remains found in the Dakota Group, eleven species referred to Laurus, four to Persea, five to Cinnamomum, one to Oreodaphne, two to Lindera, eleven to Sassafras, or twenty-six species omitting those of Sassafras (Araliopsis), eight species which, as far as known now, have an equal degree of affinity with Sassafras and Aralia. From the schists of Atane, Heer has described four species of Laurus, one of Sassafras, and one of Cinnamomum. Of Laurus, two species are identified at Atane and in the Dakota Group, and one Cinnamomum (*C. sezannense*), is recognized not only in the Cenomanian of Greenland and of Kansas, but also in the Senonian of Patoot and in the Eocene of Sézanne. The distribution of that species, or its presence at Patoot, is the more remarkable since the Laurineæ, as yet, are comparatively rare in the American Senonian, where three species only are recorded from Patoot, and one from the Princeton collection made in Wyoming. In the Laramie Group the Laurineæ are represented by eleven species, six of them described by Prof. Ward; a single one, a Cinnamomum, has been found in the Green River Group. From the Miocene, especially of California and Oregon, five species of Laurineæ are recorded.

The leaves of Laurus, though variable in their form and in some details of their nervation, the characters, especially considered for the determination of the species, are mostly of the type of *Laurus primigenia*, and represented in the Dakota Group in the leaves of *L. primigenia* var *cretacea*. The common form of *L. primigenia* is recorded at Patoot by Heer and in the flora of the Laramie Group by Ward. The type is represented in the Miocene of Oregon and California by *L. californica*, passing to the present Laurus or *Persea caroliniensis* by the leaves described as *L. pseudo-caroliniana* from the auriferous gravel deposits of California.

The species of Persea, especially *P. Schimperi* and *P. Hayana*, find their analogy in *P. palæomorpha*, of the flora of Gelinden; *Laurus (Persea) Delessii* Sap., of Sézanne; *L. grandis*, of Corral Hollow, California, and *Persea caroliniensis*.

Three species of Cinnamomum of the Dakota Group are identified in more recent formations: *C. Heerii* with *C. affine* of the Laramie Group, and *C. polymorphum* of the Miocene; *C. Scheuchzeri* and *C. sezannense* by truly identical species of the Eocene and of the Tertiary. If no representative of Cinnamomum is left in the present flora of North America, the absence is accounted for by the same cause which has forced the disappearance of species of Ficus and of a few other groups of plants which now inhabit countries under the same degree of latitude but with a climate subject to more moderate variations. *Cinnamomum affine* has an allied living representative in *C. camphora* of Japan.

Sassafras has eleven species in the flora of the Dakota Group and two in that of Atane. One of these, *S. arctica*, is related to *S. cretaceum;* the other, referred to *S. recurvata* Lesq., of the Dakota Group flora, is founded upon two fragmentary leaves scarcely identifiable with the species. In more recent formations *S. Pfaffiana* Heer, recorded from Patoot, is also founded upon a fragmentary leaf. Its relation to any of the species described is not well defined. Still from the Upper Cretaceous one species is recorded and figured by Dawson from Vancouver Island.

From the Laramie Group and from the Tertiary of North America no other species of Sassafras are recorded except *S. Selwyni* Daws., from a Tertiary locality near Souris River in Canada. In Europe the first leaves of Sassafras were described by Saporta from Sézanne as *S. primigenia.* The affinity of this species is with *Lindera Masoni* of the Dakota Group. Besides the species of Sézanne, only two others are recorded from the Miocene of Europe, both more or less closely allied to *S. cretaceum.* This last has the greatest affinity with the living *S. officinale*, being represented by trilobate and by nearly entire leaves in the same manner as are those of *S. officinale*, being either simple or palmately lobed. The leaves of *Lindera Masoni* are remarkably similar to those of *Lindera (Sassafras) triloba* of Japan.

Of the Ulmeæ no remains have as yet been observed in the Cenomanian, but Heer has described leaves of Planera from Patoot, and Dawson records a fragment doubtfully described as *Ulmus dubia*, from the Upper Cretaceous of Vancouver Island. As Ulmus leaves are found abundantly in the Tertiary measures of both continents, three species having been already described from Sézanne by Saporta, it is probable that the presence and origin of the genus may be recognized by further researches in the fossil remains of the Dakota Group.

Comparatively few fossil remains of the division Gamopetalæ have as yet been found in the Cretaceous. This is easily accounted for by the mostly herbaceous nature of the plants which compose it; the Compositæ, for example, the Rubiaceæ, Solanaceæ, Labiatæ, Scrophularineæ, Primulaceæ, etc., are all plants of soft tissues that are rapidly destroyed by maceration. Of the few tribes or families entirely or partly composed of woody plants like the Loniceræ, Oleaceæ, Ebenaceæ, Ericaceæ, etc., abundant fossil remains are found in the Middle and Upper Cretaceous of Greenland and of North America.

In the Caprifoliaceæ numerous leaves of four species of Viburnum of the types of the living *V. nudum* Linn., of *L. lantanoides* Michx., and *V. ellipticum* Hook., have been described from the Dakota Group. None of this genus has been as yet recognized in the flora of the schists of Atane, but three species are described by Heer from Patoot, which are also typically allied to some of the species composing the present flora of the United States; and another is represented by leaves and seeds in the Upper Cretaceous of Montana. From the Laramie Group twenty-two species of Viburnum are recorded, two of them described by Dr. Newberry, eleven by Prof. Ward, and the others by myself, with still four species from the Tertiary of the Bad Lands, two of them recognized also as in the Laramie. All have a more or less marked degree of affinity with species of the present flora of North America. Indeed, from the numerous representatives of Viburnum in our ancient and living flora, the genus appears to be mostly American, for in Europe nine species only are described as fossil, of which number three are from the Upper Cretaceous of Gelinden, one from that of Westphalia, and six from the Tertiary, counting one described from Sézanne. The relative proportion is preserved in the flora of our epoch, for while three species only of Viburnum are known in Europe we have twelve in the North American flora, all except one inhabiting the Atlantic slopes.

Leaves of Diospyros are found in different stages of the geological formations of North America from the Cenomanian upwards to the present epoch. Seven species of this genus are recognized and described in the flora of the Dakota Group, two of which are also found in that of Atane, and two in that of Patoot. From the Middle Cretaceous of Canada Dawson records one species and one from the Upper Cretaceous of Vancouver Island. In the flora of the Laramie Group, the genus has three species and the same number in that of the American Miocene. No species of Diospyros is recorded from any stage of the European Cretaceous and also none remain in its present flora, though about twenty species have been described, either from leaves or from fruits and calyces from the Tertiary of that continent. The Persimmon, *Diospyros virginiana* Linn., is the only species remaining in the present North American flora. It reproduces in certain characters of its leaves those of some of its ancestors in the Dakota Group.

The characters of the leaves of the Ericaceæ are often obscure or similar to the leaves of plants of other botanical divisions, therefore the references of fossil leaves to particular genera of the family, or even to the order, are often subject to criticism. As far as known, up to the present time, the Ericaceæ are represesented in the Dakota Group by five species of leaves of Andromeda, two of which are also found in the schists of Atane. None are recorded from the Upper Cretaceous, although in the Tertiary of Greenland Heer has recognized five species of Andromeda and one of Vaccinium. From the Laramie Group only one species is described, and from the Tertiary measures we have three species of Andromeda and one of Vaccinium from the Green River Group, and two species of Vaccinium from the Miocene, one of these being common to the flora of the Green River Group, and one Andromeda. This is very little, indeed, and not in accord with what is known of the distribution of the Ericaceæ in Europe. From the Tertiary of that continent, seventy-two species distributed in eleven genera have been described, the largest number of them made from leaves of Andromeda (Leucothoë) and Vaccinium. In the flora of our epoch, Europe has only thirty species of Ericaceæ, while from the Atlantic slope of the United States sixty-seven species distributed in twenty-eight genera are known, and from the Pacific slope forty-four species distributed in twenty genera, or fifty-four species in all. Twelve of the whole number are common to both the eastern and the western slopes. From this it would appear that a large number of Ericaceæ, especially species of Andromeda and Vaccinium, have been introduced into our flora after or during the glacial period, while the preponderance of Ericaceæ in the European Tertiary is against the supposition that the plants of the Gamopetalæ have passed, later than those of the two other divisions, through the modification of their characters and are thus of more recent origin.

The orders of the division Polypetalæ are largely represented in the flora of the Dakota Group, especially in the genera to which belong the woody or arborescent plants now generally or even exclusively pertaining to the North American flora. The Araliaceæ by Aralia; the Ampelideæ by Cissus or Cissites; the Cornaceæ by Cornus; the Hamamelideæ by Hamamelites; the Magnoliaceæ, especially by Magnolia and Liriodendron; the Menispermaceæ by Menispermites; the Malvaceæ by Sterculia; the Aceraceæ by Acerites and the Sapindaceæ by Sapindus; the Celastrineæ by Celastrus and the Rhamneæ by Ceanothus; the Juglandeæ by Juglans and the Anacardiaceæ by Rhus.

A number of the leaves of the Dakota Group are referred to the genus Aralia by clearly defined characters of their nervation and the form of their palmately lobed leaves, while others, which have been separated under the generic name of Araliopsis are like some leaves of the other Cenomanian prototypes or of complex character, which relate them indifferently to several genera; to Platanus, by the size and shape of the leaves; to Sassafras by their trilobate form; or to Aspidiophyllum by the prolongation of their base into a round or dentate shield, etc. As the peculiar polymorphism of these leaves has been separately examined, the present remarks are limited to the distribution of the leaves of Aralia. Eleven species of this genus are described from the Dakota Group; the finest of them, *A. Saportanea* Lesq., represented by numerous leaves, reappears in its more essential characters as *A. Looziana* in the flora of Gelinden and in that of the Laramie Group. Of the other species of the same formation, *A. tenuinervis* Lesq. is represented with a remarkable affinity of characters in *A. angustiloba* Lesq., of the auriferous gravel deposits of California, and also in *A. Jorgenseni* Heer, of the Tertiary of Greenland. Heer has described two species from the schists of Atane and one from Patoot, none being recorded from the Upper Cretaceous of Wyoming and Montana. From the Cenomanian of Bohemia two species of Aralia are described by Velenovský; one of them, *A. decurrens*, is apparently identical with *A. Saportanea* of the Dakota Group.

None of the fossil species of Aralia can be regarded as closely allied to any of those of the present flora of North America. *A. Whitneyi*, of the auriferous gravel deposits of California, allied to *A. notata* of the Laramie Group, has its typical relation to *A. papyrifera* of Japan.

Seven species of Aralia are still present in the flora of North America, one of them only pertaining to that of the Pacific slope.

From the European Tertiary thirty-two species are recorded, five of which are in the flora of Sézanne, none, however, being known in the present flora of Europe.

The tribe Hedereæ is represented in the Dakota Group by eight species of Hedera and in that of Atane by four species. Two of these which I refer to Hedera, *H. orbiculata* and *H. ovalis*, are described by Heer under the name of Chondrophyllum, one of them being also recorded in the Milk River series of Canada. Of the two other species from Atane, one, *H. primordialis*, is recognized in the Cenomanian of Bohemia; the other, *H. cuneata*, has also been found at Patoot. Of the species of the Dakota Group, one, *H. cretacea* (Pl. XVIII, Fig. 1), is evidently the type of *H. Strozzii* Gaud., of the Miocene of Tuscany, and of the living *H. helix* Linn., the common ivy, which has been found fossil in volcanic tufa of Italy. In the flora of the Laramie Group four species of Hedera are described by Prof. Ward, two of which, *H. parvula* and *H. minima*, clearly reproduce the type of *H. orbiculata*, and another, *H. Bruneri*, that of *H. cretacea*. In more recent formations, one species, *H. marginata* Lesq., is described from the Green River Group, its relation being indicated with *H. prisca* Sap., of the Sézanne flora, and is also typically allied to *H. cretacea;* another, *H. auriculata* Heer, is from the Miocene of Alaska and the Arctic regions.

The genus Cissites, as indicated by the name, is not precisely defined, being established for leaves of peculiar form, mostly discovered in the Cenomanian, and are related partly to Aralia or Araliopsis, and partly to Cissus and Vitis. Eleven species of Cissites are described from the Dakota Group, one of them also being identified in the schists of Atane. Of two other species, described by Heer in his Fl. Foss. Arct., and typically allied to *C. ingens* (Pl. XIX, Fig. 2), one is apparently Tertiary, the other, *C. puilasokensis* of Puilasok, is Senonian. From the Upper Cretaceous of Europe nothing is described except *C. lacerus* Sap. and Mar., Flora of Gelinden, Pl. v, Fig. 7, which is only a mere fragment of a leaf probably digitate, whose real form and relations are unknown. In more recent formations the leaves of the Ampelidaceæ become more defined and are referred to the genera Cissus and Vitis. We find, therefore, in Lesq., Tert. Fl., from different localities referred now to the Laramie Group, two species of Vitis, three of Cissus, one of which, *C. lobato-crenata* (loc. cit., Pl. XLI, Fig. 1), is closely related to *Cissites ingens* Lesq., mentioned above from the Dakota Group, and also to *Vitis Bruneri*, described by Prof. Ward in the Laramie flora, with three other species of the same genus. From the Green River Group we have one Cissus and *Ampelopsis tertiaria* closely allied to *A. quinquefolia* of the present North American flora.

The reference to the family Hamamelideæ of the leaves of the Dakota Group described under the generic name of Hamamelites, seems legitimate, for it has been indicated by the author of the genus, Saporta, for two species first described as *Alnus* and *Alnites* Lesq. (Cret. Fl., Pl. LXII) and later as *Hamamelites quercifolius* and *H. cordatus* Lesq. (Cret. and Tert. Fl., p. 71). And indeed the leaf of this last species figured (loc. cit., Pl. IV, Fig. 3), compared to some of those of the living *Hamamelis virginica* Linn., shows a striking affinity and the evidence at least of a family relationship. Five species of Hamamelites are described from the Dakota Group, and two from the Upper Cretaceous of Montana. One is recorded in the flora of Gelinden, and *H. fothergilloides* Sap. is described from the flora of Sézanne, and has been identified in the flora of the Laramie Group.

Leaves of Cornus are generally known by their peculiar acrodrome nervation. The species of the genus are about equally distributed in the geologic periods of Europe and North America, beginning in the Dakota Group, by *C. præcox* related to *C. Forchammeri* Heer, a species described by that author from the schists of Atane, and also recognized later in the Upper Cretaceous of Montana. The type is preserved in *C. Nuttallii* Audub., now living in California, and *C. asperifolia* Michx., of the Atlantic slope of North America. The flora of Patoot has two species, one of which is also found among the specimens from Montana, evidently showing the affiliation of the species in the Cretaceous stages with the original type in the Dakota Group. In more recent formations we have four species in the Laramie flora, one of them also identified in the Miocene and one in close relation to leaves of the auriferous gravel deposits of California. From the Tertiary of Europe twelve species are described, one only from Sézanne. In the flora of our epoch about twenty species are known to botanists; of these fourteen belong to the North American flora, six pertaining exclusively to that of the Pacific States.

The family of the Magnoliaceæ may be considered as the most interesting of the paleontological series of plants. The genus Magnolia first, is represented in the Dakota Group by a conical, cylindrical branch of fruit-bearing carpels, and by numerous well-preserved leaves, which are easily identified by size, form, and nervation. Nine species are described from leaves of this genus in the Dakota Group and four in the schists of Atane. Of these, two pertain to both localities and two are recognized by Dawson in the Peace and Pine River series of Canada. None have been observed in the Senonian of Patoot. But one of the species of the Dakota Group, *M. pseudo-acuminata*, has been identified in the flora of the Upper Cretaceous of Montana (Princeton collection). From the Laramie Group five species have also been described and two from the Upper Miocene beds of the auriferous gravel deposits of California. As the essential characters of the leaves of these different species are closely allied, and may be recognized in the successive formations from the Cenomanian to the present epoch, the affiliation by gradual transition of different characters of the species is put in full evidence.

Some of the leaves of the Dakota Group, for example, are so remarkably similar to those of species of Magnolia of the present North American flora that it is scarcely possible to find precise characters for separating them. Such are the leaves of *M. pseudo-acuminata* mentioned above, compared to those of *M. acuminata* Linn., the well-known and common cucumber tree of our eastern flora, which is represented in the Southern States by *M. cordata* Michx., considered by some botanists as a mere variety of the preceding. The type is recognized, as already said, in leaves collected by the Princeton expedition from Montana, in those of *M. ovalis* Lesq. of the Eocene Flora of the Mississippi, and in those of *M. californica* of the Upper Miocene of the auriferous gravel deposits of California. It is the same with *M. tenuifolia*, whose leaves are represented in the Dakota Group, being allied by their form and peculiar nervation to those of the living *Magnolia umbrella* Linn., of the Southern States.

The genus Liriodendron is represented in the Dakota Group by a large number of leaves, whose characters are so peculiar and so diversely modified that they have been referred to ten different species. The diversity and multiplicity of the leaves have been already remarked upon with more details and put in full evidence. After all this, is it not remarkable that no remains of plants referable to Liriodendron have as yet been observed in the Cretaceous of Europe, and none in the Upper Cretaceous of Greenland and of North America? And in the Tertiary or more recent geological formations, the genus is recognized only by leaves with variations so little marked that they are all generally considered as referable to a single species.

It seems as if the genus had, from its first appearance, gradually lost its power of differentiation to take up, by its leaves, the unalterable characters under which it is known and described from the different stages of the Tertiary as *L. Procaccinii.* A few unimportant deviations from that specific form have been described under different names, but they are now generally recognized by authors as mere varieties. Under the name of *L. Procaccinii* Ung., Unger and Massalongo have described leaves from the Tertiary of Italy; Heer from the Miocene of Greenland, and Saporta and Marion from the Pliocene of Meximieux. These last authors, however, reproduce the figure of the leaf in Heer's Fl. Foss. Arct., vol. 1, Pl. XXVII, Fig. 5, with the name of *L. islandicum,* considering it as typical of the living *L. tulipifera* Linn., while the leaves described in the flora of Meximieux are supposed to represent an extinct type. But the deviations from the normal form of the Tertiary leaves are unimportant; therefore *L. helveticum* Fisher-Ooster, figured by Heer, Fl. Tert. Helv., Pl. CVIII, Fig. 6, and probably also the fragment described as *L. Haueri* Ett., Foss. Fl. v. Bilin, pt. 3, p. 9, Pl. XLI, Fig. 10, of which, however, the essential parts of the leaf, its outlines, are undiscernible and are also mere varieties of *L. Procaccinii* Ung. The characters of this species, derived from *L. giganteum* of the Dakota Group, are mostly reproduced in the North American *L. tulipifera* Linn., the only living species of our epoch.

The Dakota Group has numerous leaves which, by their characters, have such a degree of affinity to those of Menispermum and Cocculus, two genera still represented in the North American flora, each by one abundantly distributed species, that it is not possible to object to their reference to this family of plants. The leaves of *Menispermites acerifolius* Lesq. (Cret. Fl., Pl. XX, Figs. 1–4), compared to those of *Cocculus carolinus* DC., and of *Menispermum canadense* Linn.; those of *Menispermites grandis, M. cyclophyllus,* etc. (Cret and Tert. Fl., pp. 79 and 80, Pl. V, Figs. 1–3), compared also to some of the leaves of *Menispermum canadense,* and by their peltate mode of attachment of the petiole to those of Stephania or of *Cissampelos pareira* of Mexico, show that relation in full evidence.

In a fossil state, nine species of Menispermites are represented by leaves in the Dakota Group, two in the schists of Atane and one in the Peace and Pine River series of Canada. None have as yet been found in the Upper Cretaceous and from more recent formations one species only. *Cocculus Haydenianus* is described by Prof. Ward and figured in splendid leaves from the Laramie Group. The living flora of Europe has no representation of the Menispermaceæ.

The family Sterculiaceæ are mostly represented in paleobotany by species of Sterculia. The plants of this genus have leaves generally palmately divided from below the middle, the primary nervation derived from the top of the petiole at the basal borders, palmately three to five parted, and the secondaries numerous, either anastomosing in bows quite near the borders or gradually effaced in passing into the areolation by repeated anastomoses. These are the essential points which I have considered for the attribution of leaves to this genus, especially as distinctive from those of the leaves of Aralia, whose base is prolonged or decurring along the petiole and the primary nervation being palmately trifid and supra-basilar. These characters may be considered of little practical value, but serve as a diagnosis of the fossil leaves referred to Sterculia, and afford the means of comparing the march and distribution of these plants through the geological ages from their origin in the Dakota Group, where they are first recognized.

I have referred to Sterculia seven species or forms of leaves of the Dakota Group, some of them related to *S. labrusca* Ung., a common and variable species of the European Tertiary. None have been recorded by Heer from the schists of Atane, but one is recognized by Dawson in the Peace and Pine River series of Canada. From the Upper Cretaceous, Heer has described leaves of *Sterculia variabilis*, first described by Saporta in his Fl. Foss. de Sézanne, p. 400, Pl. XII, Figs. 6, 7; and *S. labrusca* Ung., a species commonly found in the Tertiary of Europe, is recognized in the flora of Gelinden by Saporta and Marion. Finely preserved leaves of one species, *S. modesta* Sap. (Fl. de Sézanne, p. 40, Pl. XII, Fig. 2), have been found at Golden, Colorado, (Laramie Group), and one species is described from the Green River Group. Though sixteen species of Sterculia are recorded from the Tertiary of Europe, the genus is without representatives in the present flora of Europe and of America.

Tilia and Grewia, both well characterized genera, have left abundant remains of leaves in the Tertiary, and have representatives in the flora of the present epoch. Grewiopsis and Apeibopsis, with less definite characters, related as indicated by the names to Grewia and Apeiba, are represented in palæobotany from the Cenomanian, but become extinct in the recent stages of the Miocene. *Apeibopsis Thomseniana* Heer has been described from the schists of Atane, and leaves scarcely differing from those of Atane have also been described from the Dakota Group as *A. cyclophylla*.

At a higher stage of the Cretaceous, in Montana, another species of Apeibopsis is also found. The genus Grewiopsis is less positively recognized. Numerous leaves of the Dakota Group have been referred to this genus under the specific name of *G. Haydenii.* By their nervation they have a degree of affinity to those of Tilia. A fruit also of *Nordenskiöldia* Heer, a new genus whose relation is apparently to the Tiliaceæ, is described from the same formation. Taken altogether, these remains bear testimony to the origin or presence of the Tiliaceæ in the Dakota Group. Of nine species to Grewiopsis recorded in the flora of the Laramie Group, five are described by Prof. Ward and four by myself. The genus Grewia is first recognized in the Laramie Group by four species, and later in the Miocene of Oregon by one; four species of Grewia are also described by Heer in his Fl. Foss. Arct., all from the Tertiary of Cape Lyell, Spitzbergen.

Leaves of Tilia have not been observed in the fossil flora of North America before the Tertiary. *T. antiqua* Newb. (*Viburnum tilioides* Ward) is from Fort Clark; another, *T. populifolia* Lesq., is from Florissant, in the Green River Group. *Tilia Malmgreni* Heer, and *T. alaskana* Heer, are recorded from the Arctic Miocene, or Eocene as it is now called.

Ettingshausen first described in his Kreideflora of Niederschoena, as *Acer antiquum,* a leaf attributed to this genus, from its similarity of form to those of *A. decipiens* Heer. This attribution was, however, generally considered doubtful, and the origin of the genus referred to Tertiary age. A number of leaves recently discovered in the Dakota Group of Kansas and described under the name of *Acerites multiformis* (Pl. XXXIV, Figs. 1–9), confirm, by their characters, the determination of Ettingshausen and prove the existence of representatives of this family in the Cenomanian.

No remains of Acer have been found in the schists of Atane, but Heer has recognized two species in the Senonian of Patoot, and in more recent formations from the base of the Laramie Group fossil remains of plants of this genus have been found in abundance. In the Tertiary of Greenland Heer has ten species. Prof. Ward has described two in his Laramie flora, and I have found seven species in the different stages referred to the Laramie, and two species in Upper Miocene strata of the auriferous gravel deposits of California. More than sixty species of Acer and two species of Negundo are described from different stages in the European Tertiary. In the living flora fifty or more species are known, mostly inhabiting the northern hemisphere, and being equally distributed between Europe and North America; seven species in Europe, five in the Atlantic States of

North America, three in the Western States, with one species of Negundo each in the Western and Eastern States. Of the genus Negundo one Miocene species is described from Europe and one from North America, the latter from the Fort Union Group by Dr. Newberry.

I have also described as *Negundoides acutifolia* in Cret. Fl. (p. 97, Pl. XXI, Fig. 5) fragments of two leaflets found in the Dakota Group, and apparently part of a compound leaf, which I could relate only to the leaves of *Negundo Californicum* Torr. and Gray. On account of the insufficient characters of these fragments it is not possible to consider them as original representatives of Negundo, nor even perhaps to admit them in the Aceraceæ.

The Sapindaceæ have distinct representatives in numerous leaves of Sapindus in the Cenomanian of Greenland and of North America. From the schists of Atane Heer records two species of Sapindus, one of them, first described from specimens of the Dakota Group, is also found in the Upper Cretaceous of Patoot. No other species is known from the Upper Cretaceous, but the genus is represented in North American Tertiary by eleven species, two of them recorded from the Green River Group and two from the Fort Union Group. At this epoch the Sapindaceæ are mostly distributed in the tropical regions. One species of Sapindus only remains in the North American flora inhabiting the coast of Florida and Georgia.

A number of coriaceous leaves, whose relation to Celastrus is indicated by their form and nervation, have been referred to this type under the name of Celastrophyllum. Their characters are not clearly defined and therefore their relation to living species of Celastrus is not positive. In the leaves of the Dakota Group I have recognized three species of Celastrophyllum, one of which, *C. decurrens*, is closely related to *C. lanceolatum* Ett., of the Cenomanian of Niederschoena, Saxony, and is also reproduced with distinct affinity in *C. Benedeni* Sap. & Mar., of the Senonian of France. Heer has described three species of this same generic division and one of Celastrus from the Senonian of Patoot. The genus Celastrus is abundantly represented in the more recent geological formations. From the Laramie Group Prof. Ward describes seven species of Celastrus, and from localities referable to the same group I have recorded in Tert. Flora two species of Celastrinites with three species of Celastrus, one Celastrinites from the Green River Group and one Celastrus from the Miocene of Alaska. *Celastrus scandens* Linn., is the only living species remaining in the North American flora. Though more than sixty species of Celastrus, including four of Celastrinites, have been described from the Tertiary of Europe, no Celastrus is known in the present flora of that continent.[1]

In the Ilicineæ, leaves of Ilex are distinctly characterized and their generic affinities positively ascertained. I have described five species of Ilex from the Dakota Group, and Heer has described one from Atane and two from Patoot. *Ilex borealis* Heer, described from Patoot, is recognized also in the Dakota Group and represented in Pl. XXXV, Fig. 8, this volume, while *Ilex dakotensis* has a marked affinity to *I. stenophylla* Ung., of the Miocene, and especially to *I. glabra* Gray, of the living flora of North America. Two species of the Dakota Group, *I. armata* and *I. papillosa*, typically represent the American Holly, *Ilex opaca* Ait., together with a number of species of the Tertiary which have coriaceous, spinose leaves. No species of Ilex has been as yet described from the Laramie Group, but we have ten species from the Green River Group and one from the chalk bluffs of the auriferous gravel deposits of California. From the Tertiary measures of Atane five species are known, and two from Alaska. Remarkably enough, the genus, of which more than thirty species are recorded by Schimper from the Tertiary of Europe, a number of them closely related to the species of the present flora of North America, is at this epoch represented in the flora of Europe by a single species, while ten inhabit the Atlantic slope of the United States, and none that of the Pacific.

Of the order Rhamneæ fossil remains have been referred to Paliurus, Zizyphus, Ceanothus and Rhamnus, all genera in which the leaves are easily recognized by their peculiar nervation. Five species of Paliurus are described from the Dakota Group, one of which, *P. cretacea*, is closely allied to *P. affinis* Heer, of Patoot; another, *P. ovalis*, is recognized also in the Peace and Pine River series of Canada with a new species, *P. montanus* described by Dawson. Of Zizyphus, one species is known from the Dakota Group and also from Patoot; and of Ceanothus, none as yet have been seen in the Dakota Group, but Heer has one species from Patoot and Dawson one from Vancouver Island. Of Rhamnus, the Dakota Group has five species, and Heer has two from Atane and one from Patoot. *R. similis*, of the Dakota Group, is remarkably like *R. rectinervis*, a common species of the Tertiary of Europe and America, reproduced with characters of its leaves in the

[1] The characters of Celastrus are difficult to fix. In the leaves of *C. scandens* the secondaries curve quite near the borders in regular, smooth, or slightly angular bows, emitting short straight nervilles directed towards the borders, indifferently entering the small, curved-up teeth or any part of the borders, even the sinuses between the teeth. The size of the leaves is very disproportionate, varying upon the same bush from 3^{cm} to 15^{cm}, even with some enlarged leaves measuring 15^{cm} in width and 17^{cm} in length.

living *Frangula caroliniana* Gray; while *R. inæquilateralis*, also of the Dakota Group, is typically allied to *R. æningensis* of the Miocene of Europe. Of the Rhamneæ, Gelinden has only one species, a Zizyphus. But the different genera of the family become more and more richly represented in the Laramie Group and the more recent formations. From the Laramie flora Prof. Ward, besides *Berchemia multinervis*, a species common in the Tertiary of both continents, has recognized three species of Zizyphus, one of them new; three of Paliurus, one of which, the most common, is *P. Colombi* Heer. From different localities referred now to the Laramie, I have recorded ten species of Rhamnus and one of Zizyphus, besides two species of Paliurus, one of Zizyphus, two of Rhamnus from the Green River Group, and one of Zizyphus and two of Rhamnus from the Upper Miocene of the auriferous gravel deposits of California. A fine species of Rhamnus is also described in the Mississippi flora (Eocene). The types of all these genera represented in the Dakota Group may be followed by their affiliation and clearly recognized through the geologic ages to the present epoch, where the flora of North America has still in the Atlantic States one species of Berchemia, three of Rhamnus, and four of Ceanothus, while it has on the Pacific slope four species of Rhamnus, eighteen of Ceanothus, and one of Zizyphus. The preponderance of species of Ceanothus in this last flora is remarkable, and does not appear to result from ancestral influence, for no other representative of this genus has been observed in the Tertiary of North America, except *Ceanothus Meigsii* Lesq., of the Mississippi Eocene, a species distinctly related to the living *C. Americanus* Linn.

Of the order Juglandeæ, Juglans is as yet the only genus of which leaves have been observed in the Dakota Group. One species, *Juglans arctica* Heer, first described from the schists of Atane, has been later recognized in the Dakota Group with *J. primordialis* Lesq. and two other forms of leaves, which have been described under the generic name of Juglandites on account of their insufficiently ascertained relations. *Juglans crassipes* Heer, of the Cenomanian of Moletein, is also recognized in the Senonian of Patoot, and Dawson has described *J. harwoodensis* from the Upper Cretaceous of Vancouver Island, and has recognized *J. cretacea* from the Peace and Pine River series of Canada. In more recent geological times the genus becomes more abundantly represented. The Laramie Group has seven species of Juglans and one Carya; the Eocene of the Mississippi two species of Juglans; the Green River Group has five species of Juglans, with one species common also to the Laramie Group, and four species of Carya. And in the still more recent formations referred to the Miocene ten species are described, four of which are from leaves found in the auriferous gravel deposits of California; this in a flora of which only fifty-four species are known. *Carya antiqua* Newb., ascribed to the Laramie Group, has been found in the Bad Lands and the Fort Union Group, with plants of Miocene type.

The Juglandeæ show a constant increase of their representatives in the floras of the Mesozoic ages in passing from older to more recent formations. The present flora of North America has now four species of Juglans, two on each slope, and seven species of Carya, all confined to the Atlantic States. The predominance of the Juglandeæ upon this continent is the more remarkable in that, of the thirty species of Juglans still living, Europe has only one species and this in cultivation, and as far as known introduced from Persia, while thirty-four species have been described from leaves or fruits from the European Miocene, with eighteen species of Carya and five of Pterocarya. The original type of Juglans is represented in the Dakota Group by leaves with entire borders. No species with serrate leaves, like those of Juglans and Carya of our present flora, have been observed before the end of the Cretaceous.

Of the Rosaceæ we have in the Dakota Group well preserved leaves of one species of Cratægus, one of Pyrus, and two of Prunus. The leaves of Cratægus have distinct characters and are positively determined. That of *Cratægus Laurenciana* (Pl. XXXVIII, Fig. 1) has a very close relation to *C. antiqua* Heer of the Tertiary of Greenland, and both species are of a type evidently reproduced in the living *C. tomentosa* Linn., of the present North American flora. The determination of *Pyrus cretacea* Newb., based upon the form of one leaf and that of *Prunus cretacea* Lesq., determined from two fruits, may be, however, questionable, though I have found in the Senonian of Wyoming (Princeton collection) leaves referable to two species of Prunus, one of which is closely related to *P. serrulata* Heer of the Sachalin Tert. Fl. From the same formation a number of leaves have been referred to Photinia on account of their distinct affinity to those of the living *P. arbutifolia* of California, and others, together with fine large stipules, to Cratægus on account of the affinity of their characters to those of *C. japonica.* Heer has not recognized any kind of plants referable to the Rosaceæ in the schists of Atane, but has described two species of Cratægus from the Senonian of Patoot. In more recent formations, considered as Tertiary, one species of Amelanchier is described by Dr. Newberry from the so-called lignitic strata of the Yellowstone River. In the Green River Group we have one Amelanchier, one Cratægus, one Rosa, and one Amygdalus, and from the Miocene strata I have described one Cratægus from Carbon, Wyoming, one Spiræa from Alaska, one Prunus from the Bad Lands, and one Cercocarpus from the auriferous gravel deposits of California. Heer records fourteen species of Rosaceæ in the Arctic Tertiary.

The Leguminosæ, which are richly represented now in the vegetation of our globe, are as yet recognized in the Cretaceous merely by detached leaflets, whose generic relations remain uncertain. This order being essentially composed of herbaceous plants with compound leaves, with the pinnules easily detached, specimens have frequently been preserved as fossil witnesses of its ancient origin. Heer has found in the schists of Atane seventeen species of Leguminosæ, while ten have been described from the Dakota Group. Of these one is represented by a large legume, whose generic relation is still unknown.

Besides the plants to which the above remarks are applicable there are, in the flora of the Dakota Group, a number of vegetable remains whose relation to any of the vegetable groups, orders, or genera, admitted in the flora of the present epoch, has not been recognized. These plants, described under peculiar generic names (Protophyllum, Aspidiophyllum, Eremophyllum, Anisophyllum, etc.), may represent short-lived types whose disappearance is far more easily explained than their origin. For, indeed, their essential characters may have been gradually effaced by rapid modification and so intimately mixed with others that they have become unrecognizable; or, under adverse influences may have become really extinct as races unfit to remain associates of those of the future.

It is well to remark, also, that though some types of the Cenomanian, as shown by the leaves of the Dakota Group, generally remain distinct and plainly defined in the vegetation of some of the subsequent geological formations, the chain of evidence is not always continuous. A number of these, for example, still remain unrecognized in the Upper Cretaceous, though present in more recent strata of the Laramie or of the Tertiary. We know very little as yet of the flora of the Senonian or of intermediate stages between the Dakota and the Laramie Groups. But judging from recent discoveries in Wyoming, Montana, Canada, and Vancouver Island, we have been able to recognize in the scanty materials obtained the presence and therefore the persistence of some of the primitive or more ancient types, and it is most probable that further research will complete the evidence of the persistence and representation of the types of the Dakota Group up to the Laramie, as clearly as it is observable in this flora and through the different stages of the Tertiary to the present time.

Already the evidence obtained from the study of the Dakota Group remains warrants the conclusion that the flora of North America is not at the present epoch, and has not been in past geological times composed of foreign elements brought to this continent by migration, but that it is indigenous. Its types are native; the diversity of their representatives has been produced by physical influences; their affinities, therefore, or the relation of their modification or derived forms can not be looked for in the vegetation of distant countries. This evidence greatly simplifies the researches, and therefore the affinities rest upon more solid ground. These conclusions seem confirmed by the great analogy of climatic circumstances recognized as existing between the characters of the flora of the Dakota Group and those which now govern the vegetation of the North American continent. All the plants of the American Cenomanian, except those of Ficus and the Cycads, might find a congenial climate in the United States between 30° and 40° of latitude. Even the exceptions noted above may be omitted; for the growth of some kinds of plants, for example the Cycads, essentially depends on a moderate and humid climate, without striking extremes of temperature, and of circumstances like those governing the climate of the southern shores of Florida, where species of Ficus still grow luxuriantly.

A single modification of the character of the vegetation generally follows great geological disturbances which produce permanent changes in the atmospheric conditions of a country. From the base of the Rocky Mountains to that of the Alleghanies the land surface, with an expanse of more than 140,000 square miles, has remained unbroken by any chain of mountains or even by hills of moderate altitude, from the beginning of the Cretaceous period. Even the absence of drift deposits upon a great portion of these vast plains shows how little the Glacial Period influenced their physical conditions. The result has been a prolonged uniformity of climate and of course the preservation of the original types of the flora, subjected to some modification of their original characters, without destroying them or forcing their removal by the introduction of strange or exotic forms.

PLATES.

PLATE I.

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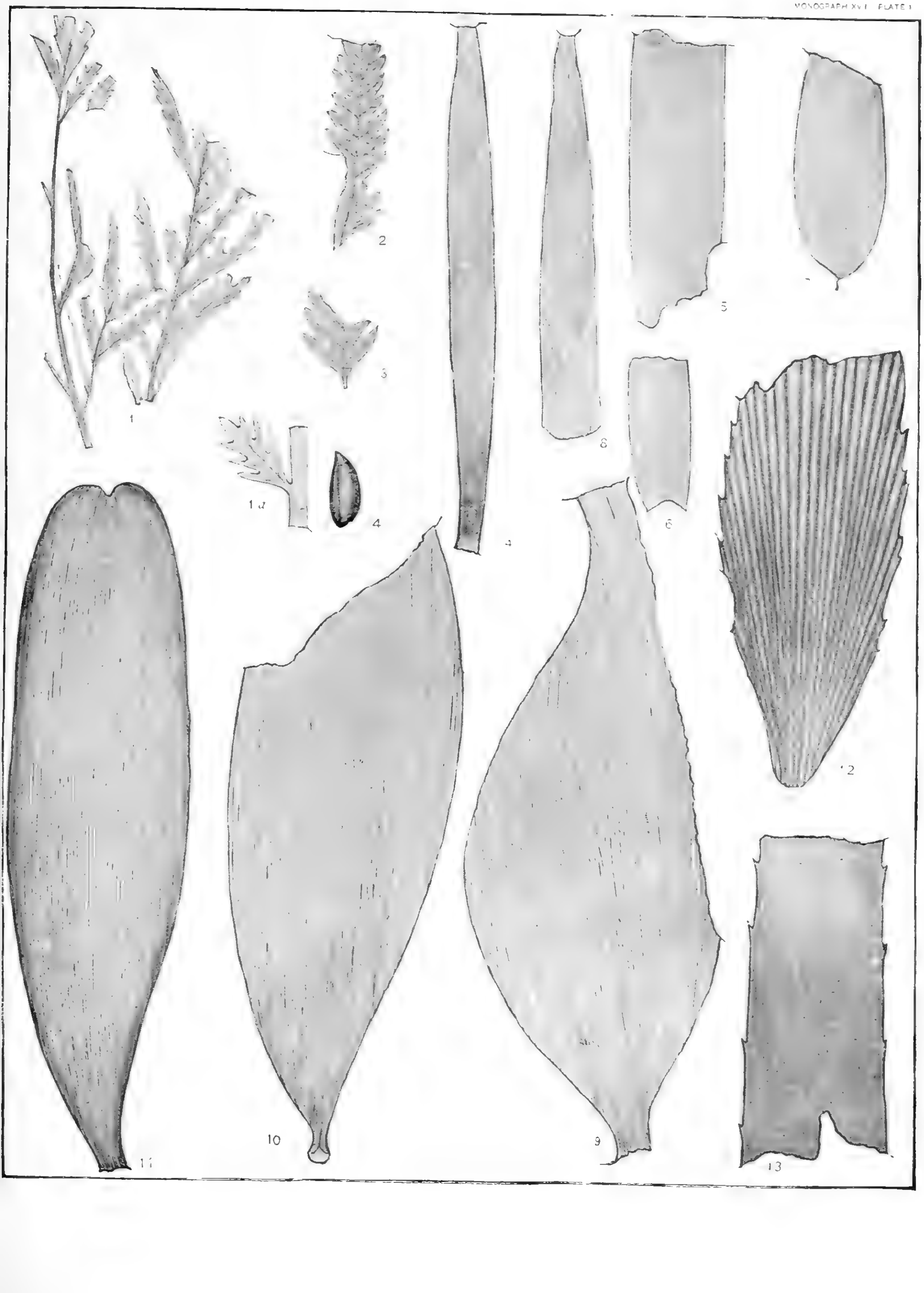
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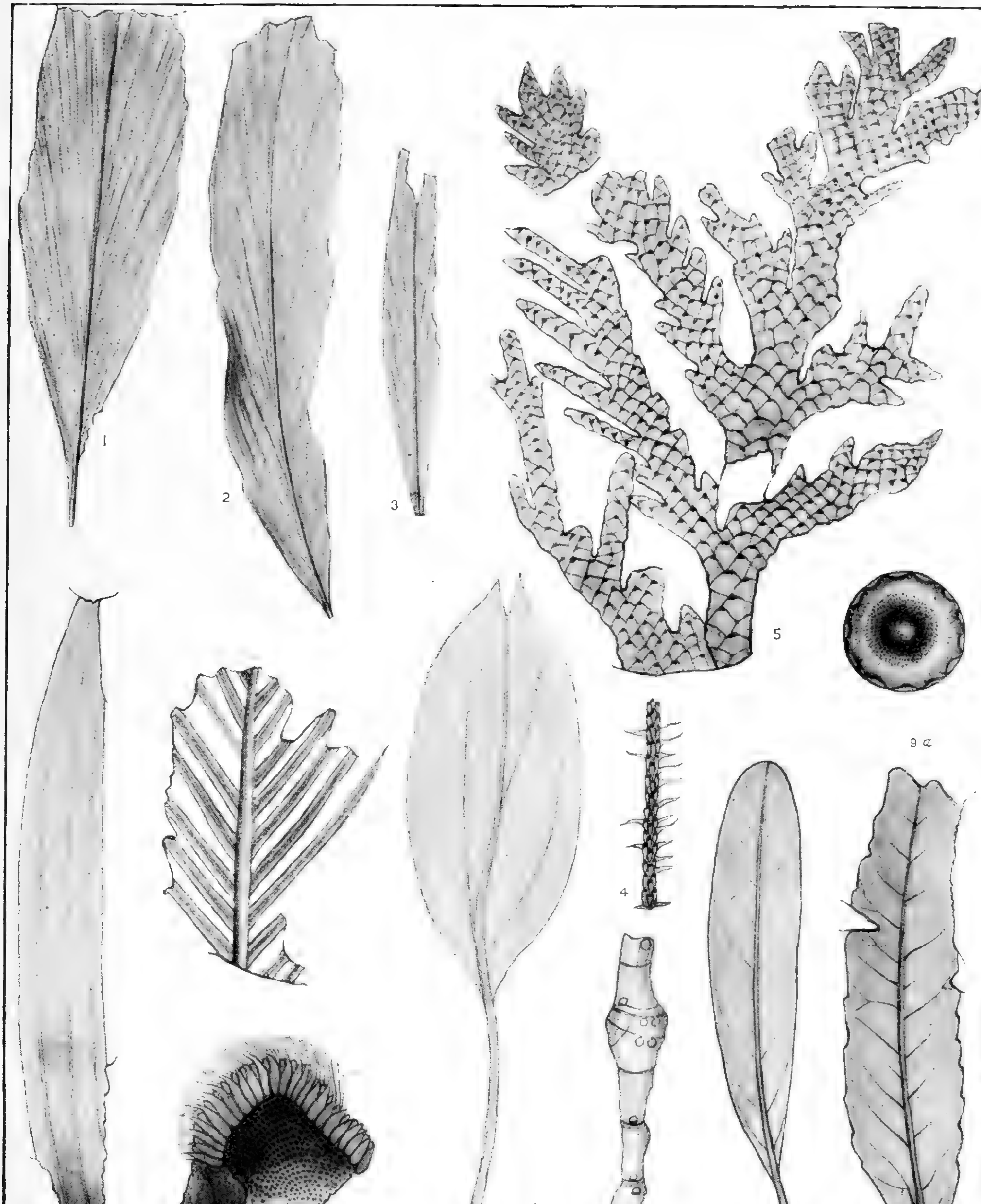
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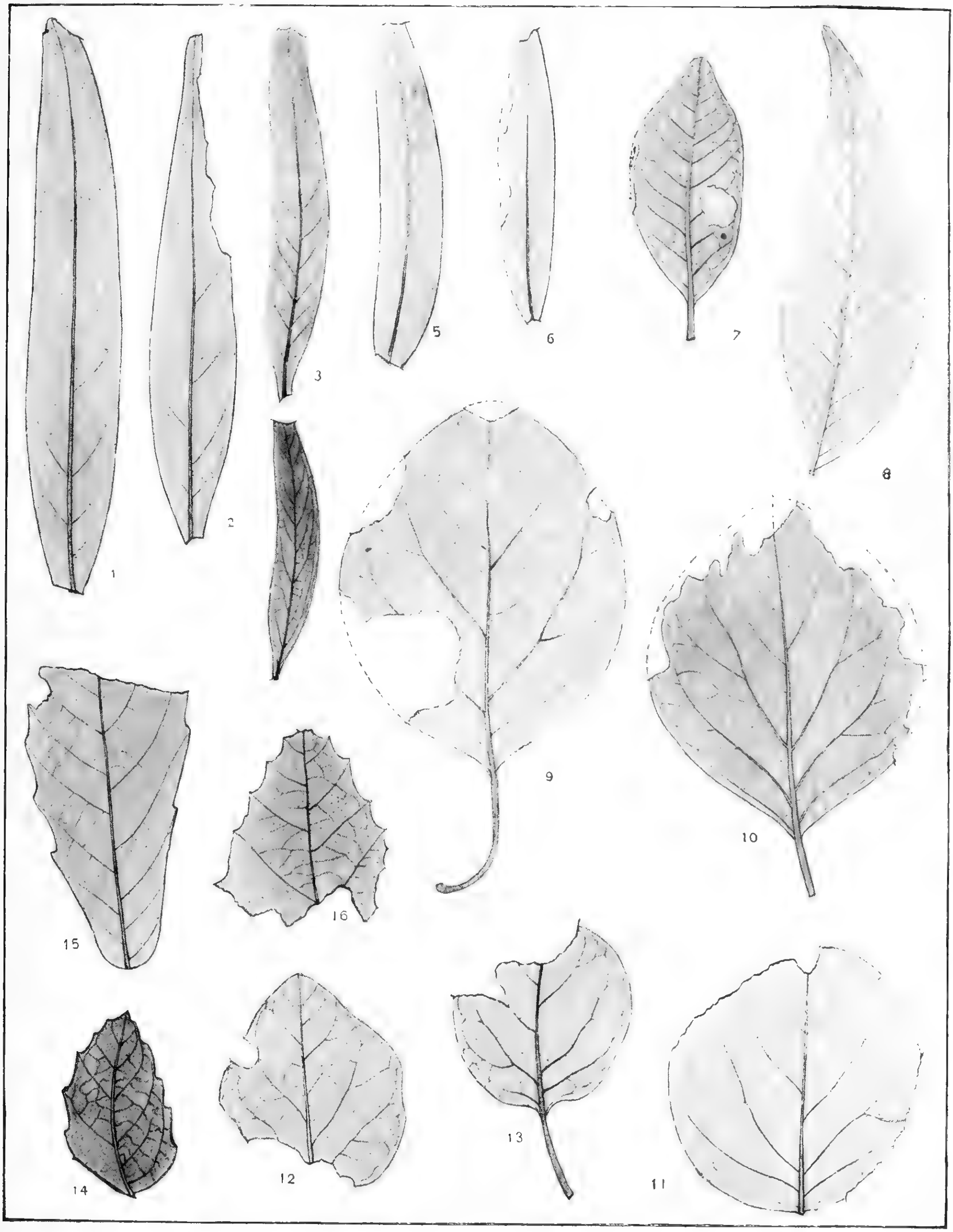
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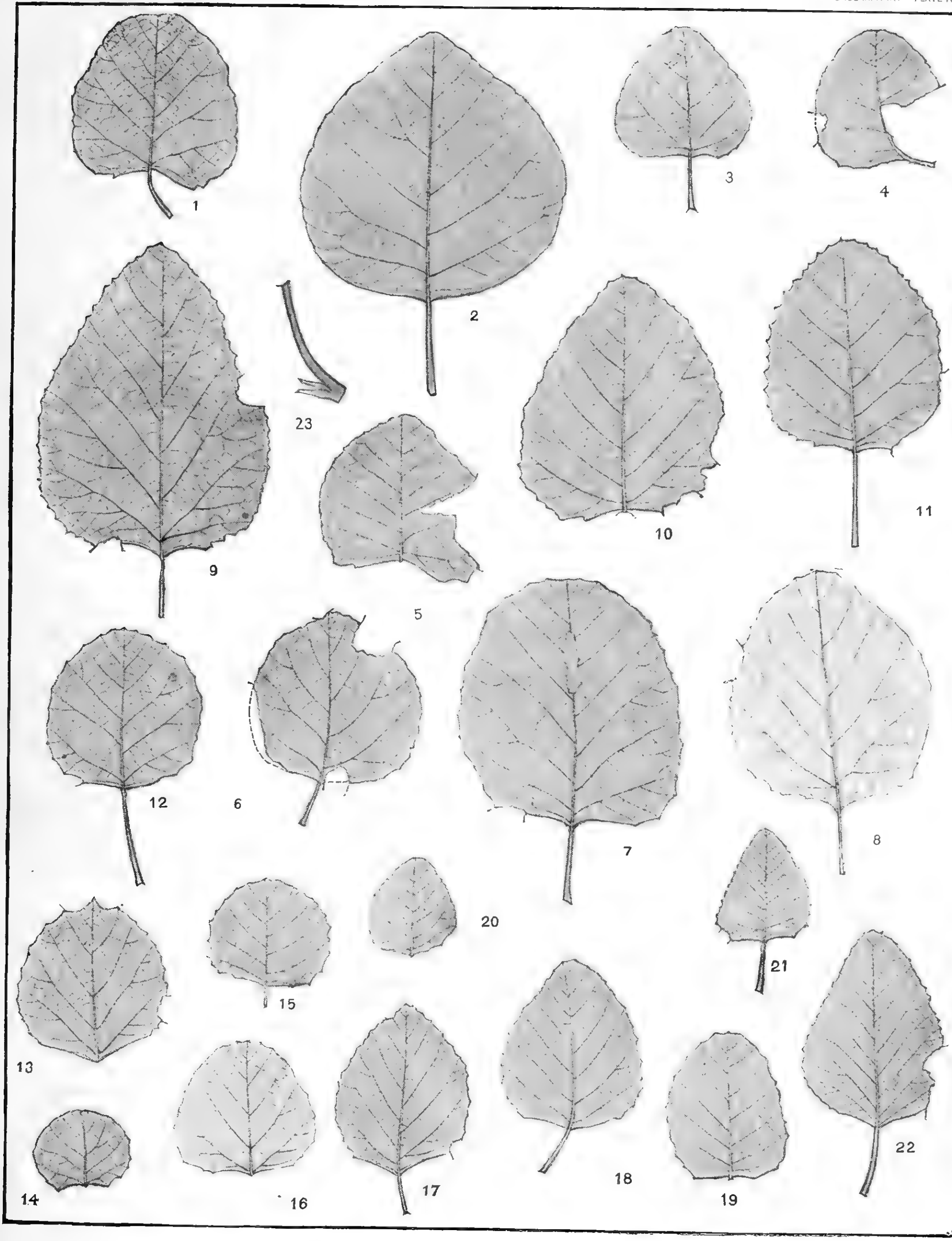
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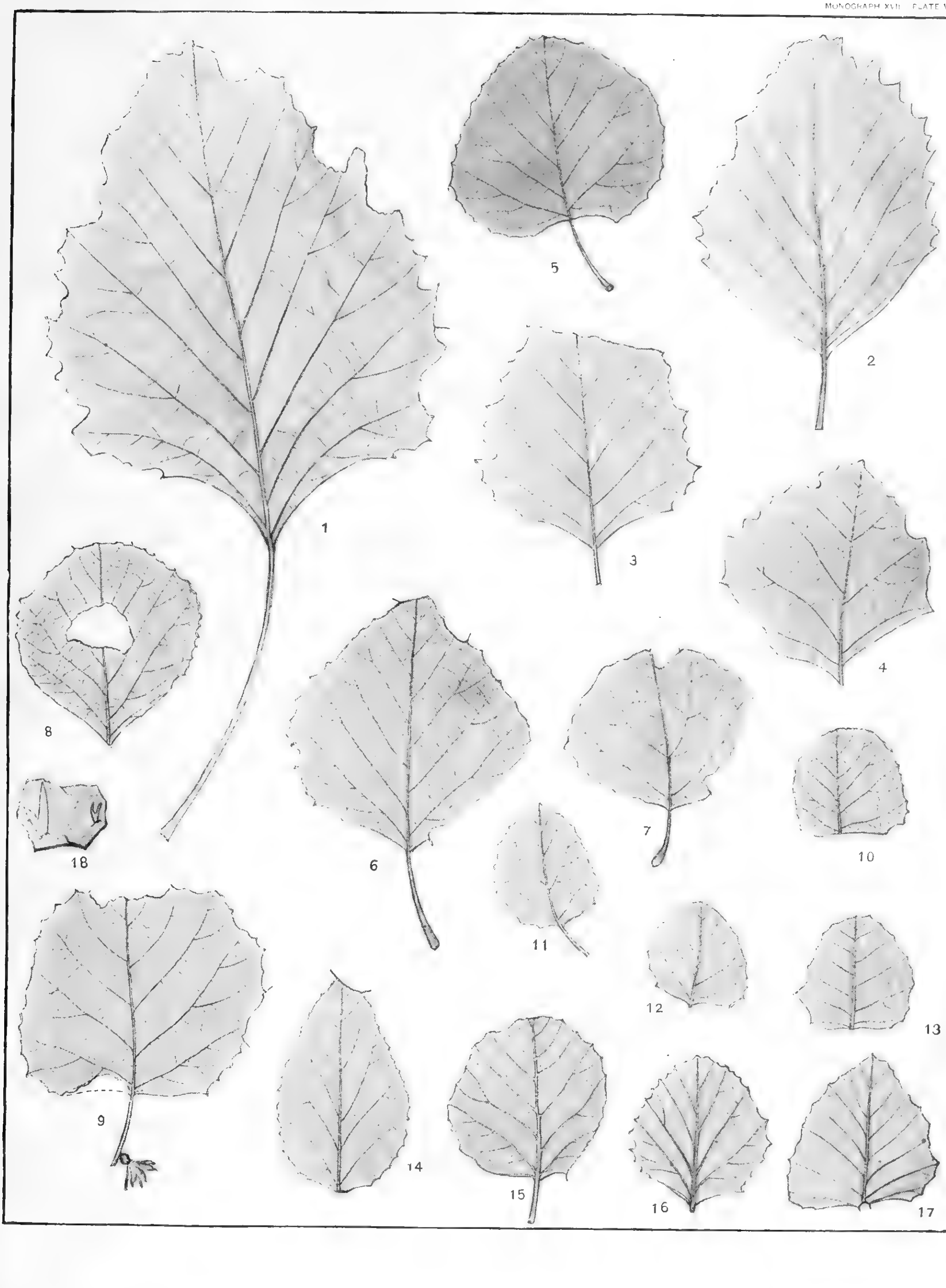
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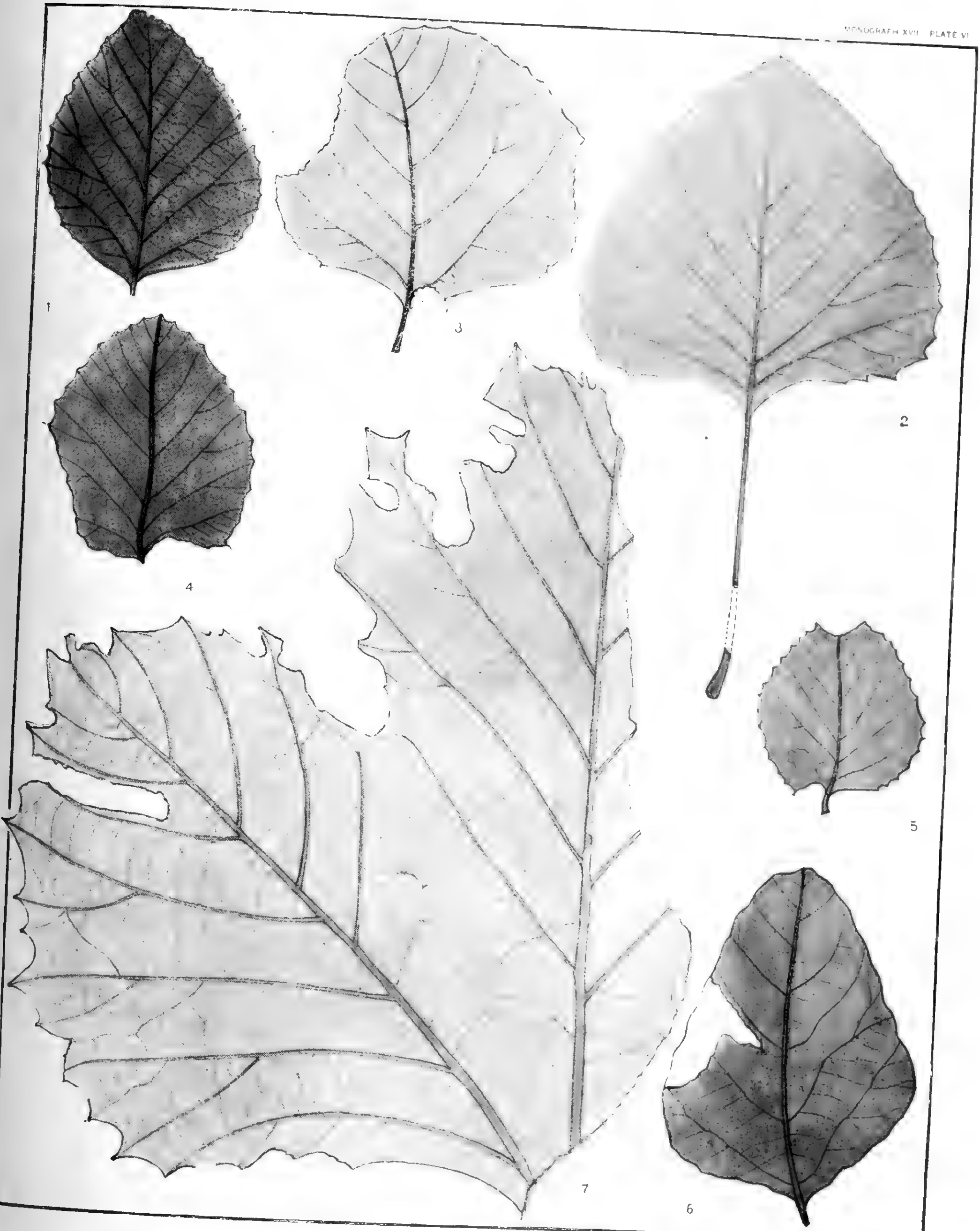
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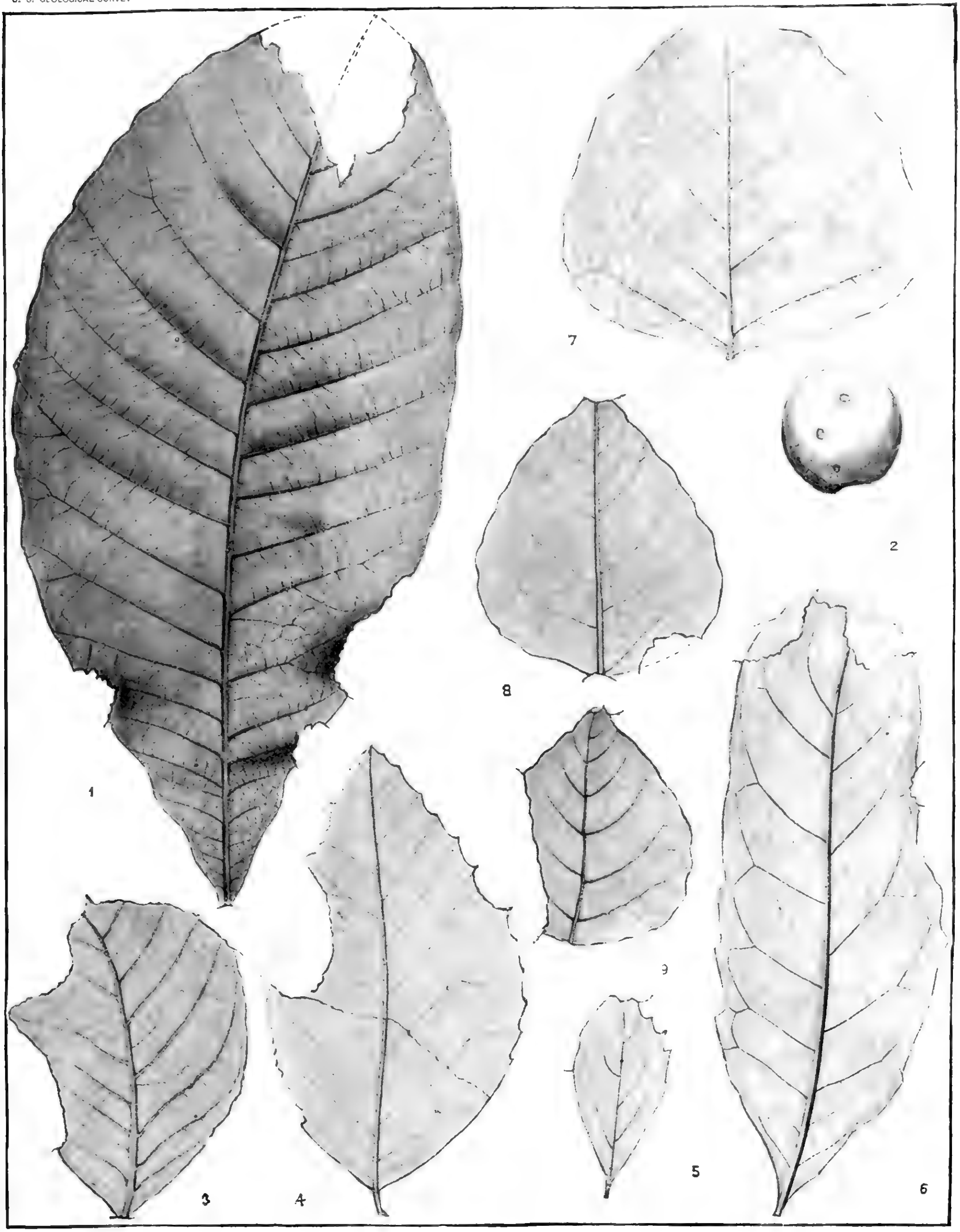

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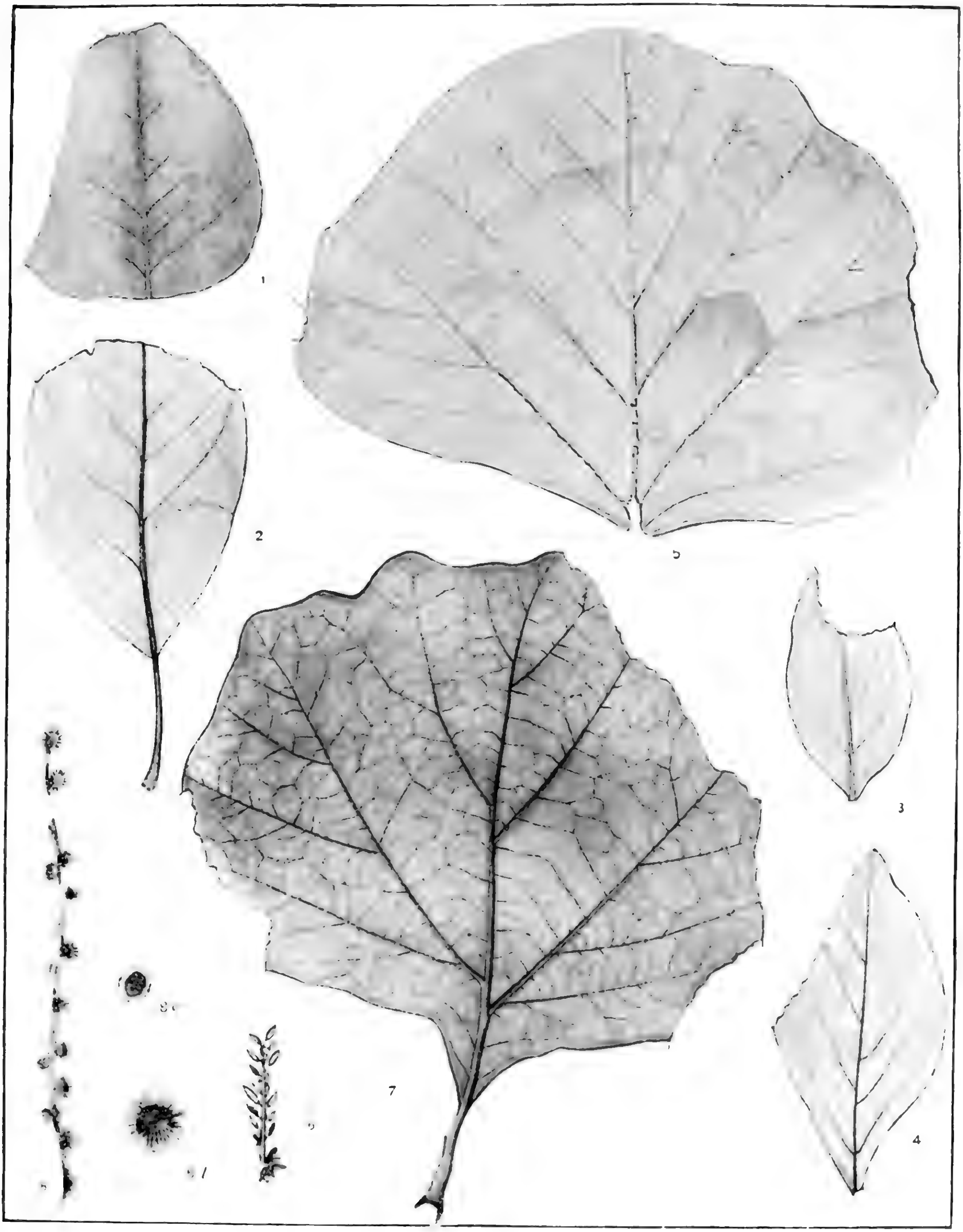

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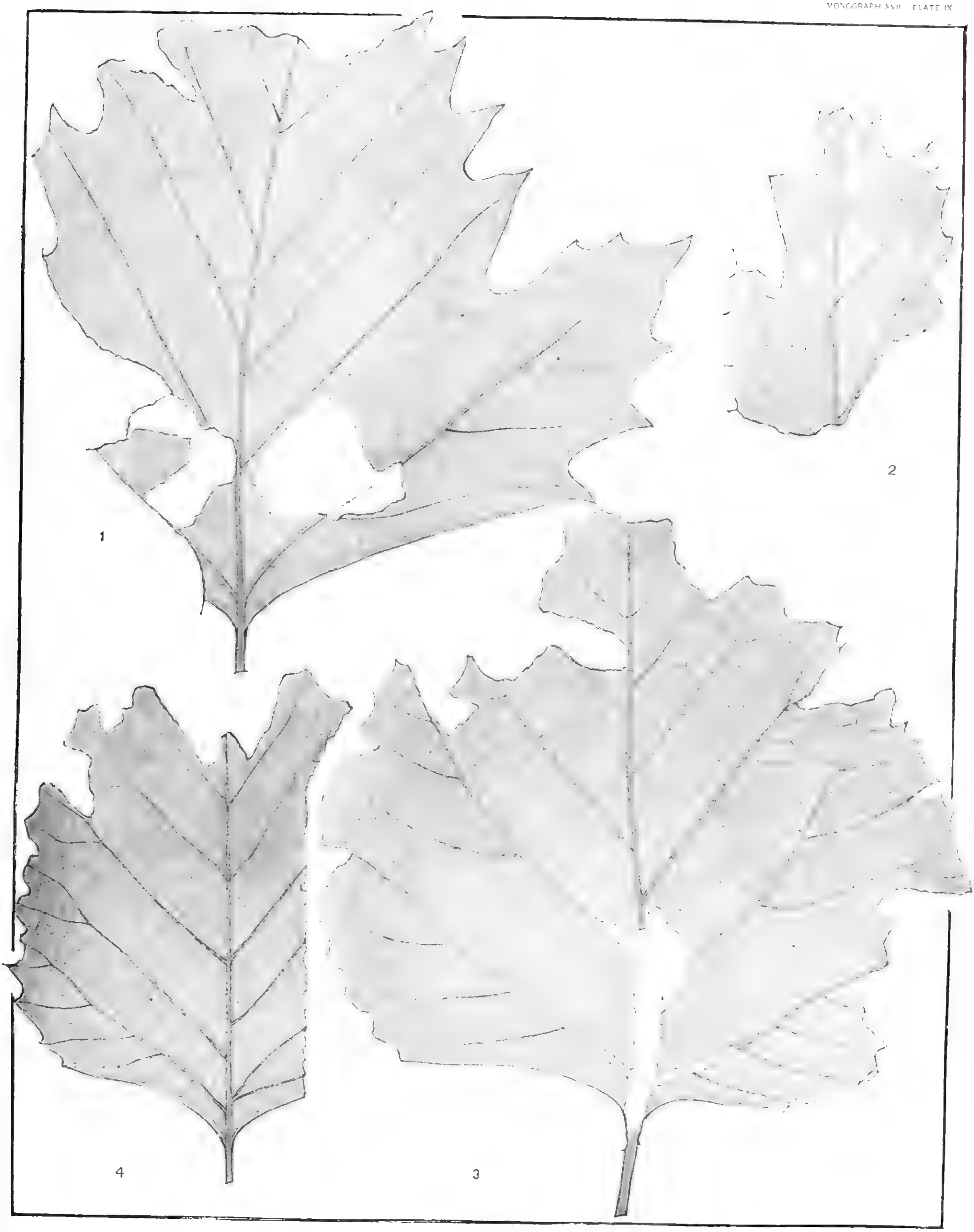

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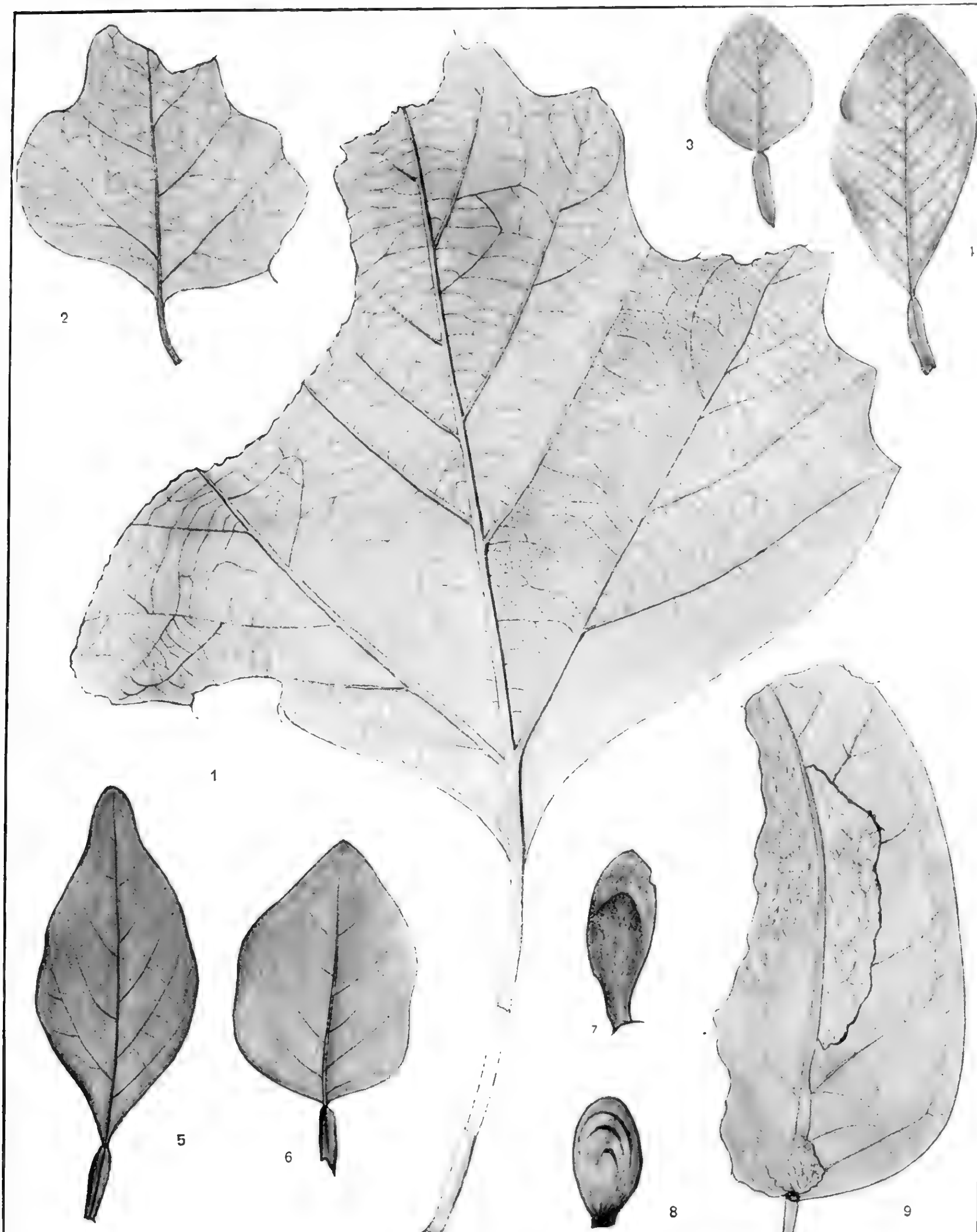
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PLATE XI.

PLATE XI.

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3.	Laurus antecedens, sp. nov	92
4.	Cinnamomum Scheuchzeri Heer	104
5.	Litsea falcifolia, sp. nov	97


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PLATE XII.

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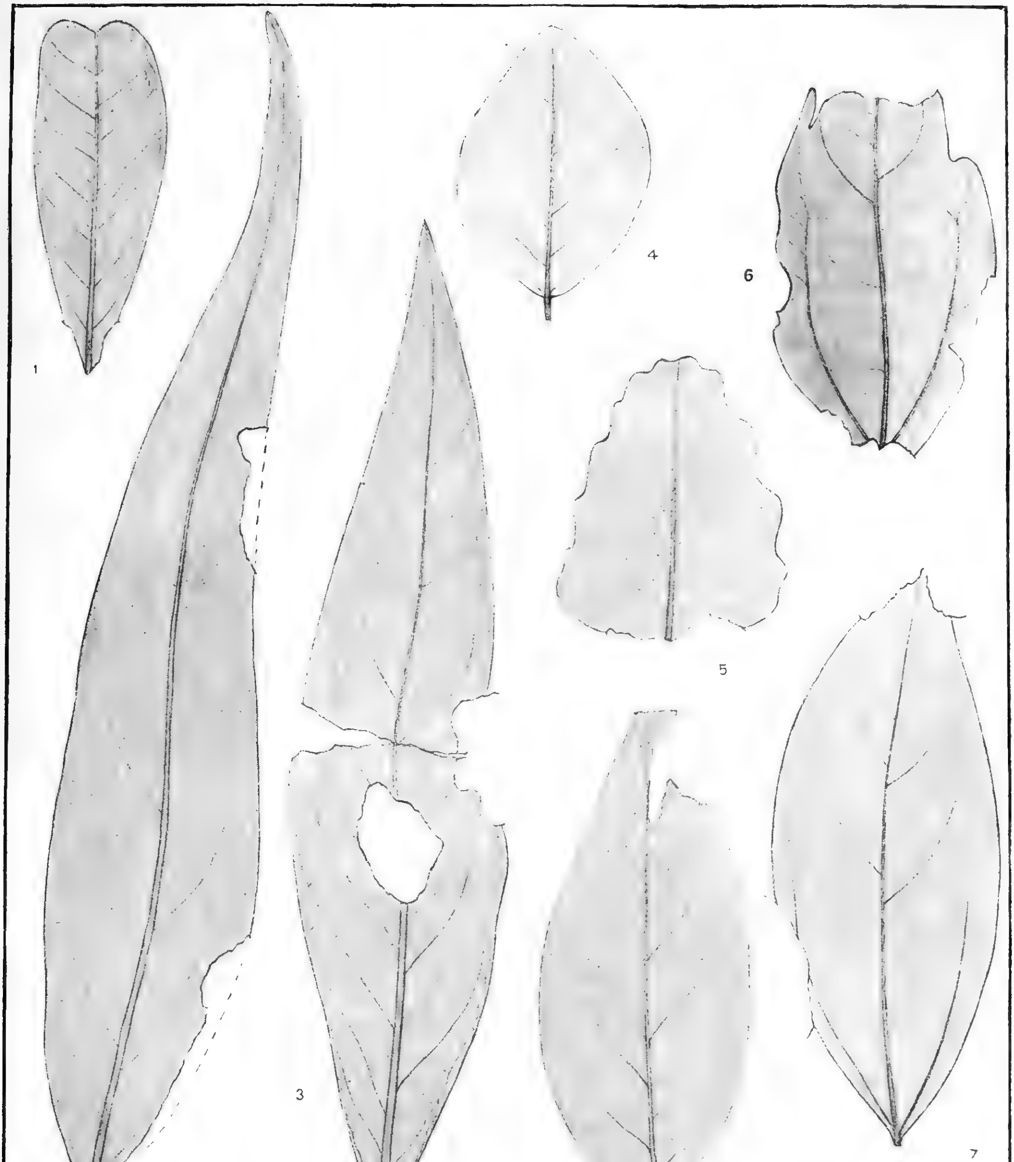
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PLATE XIII.

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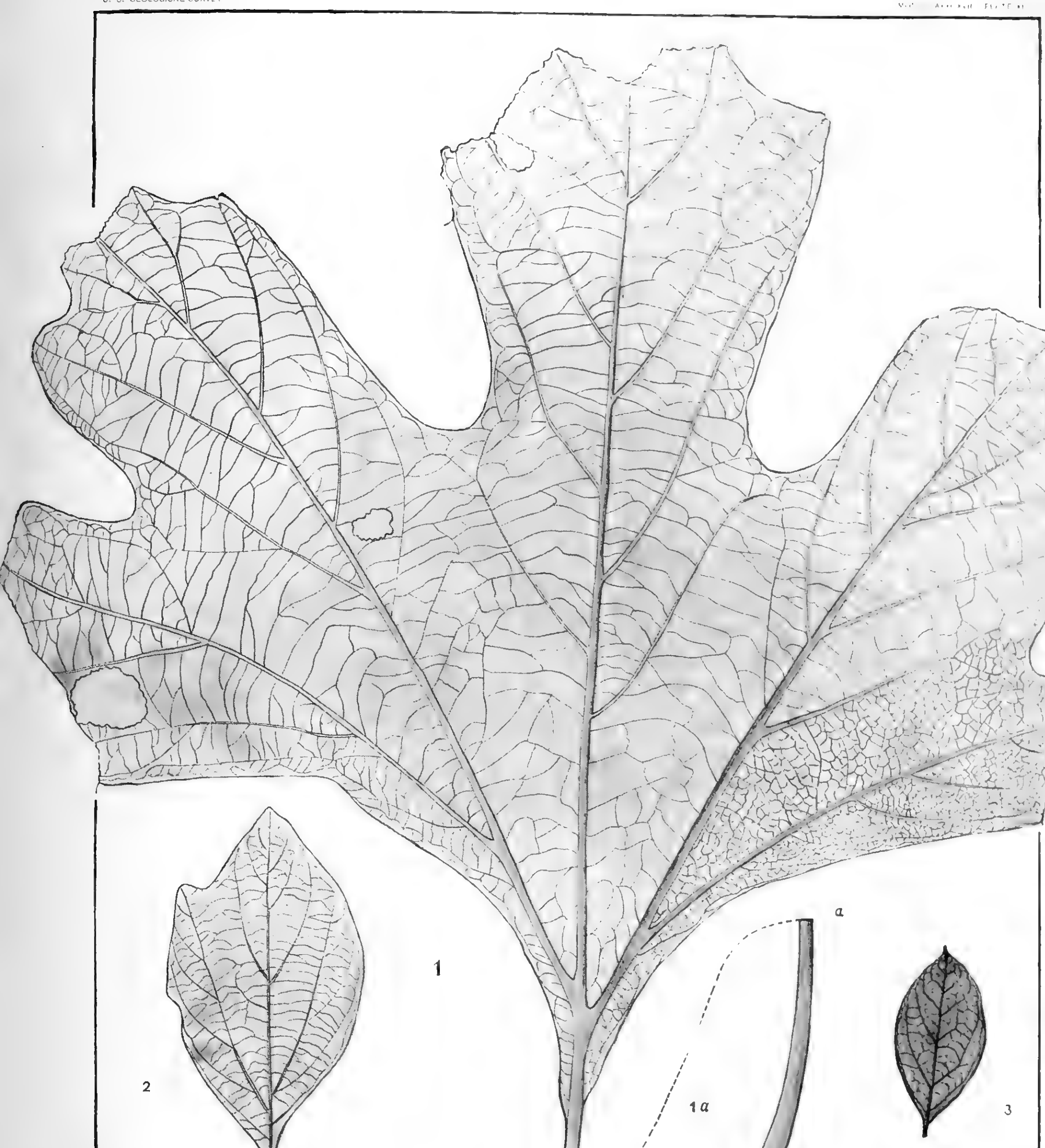
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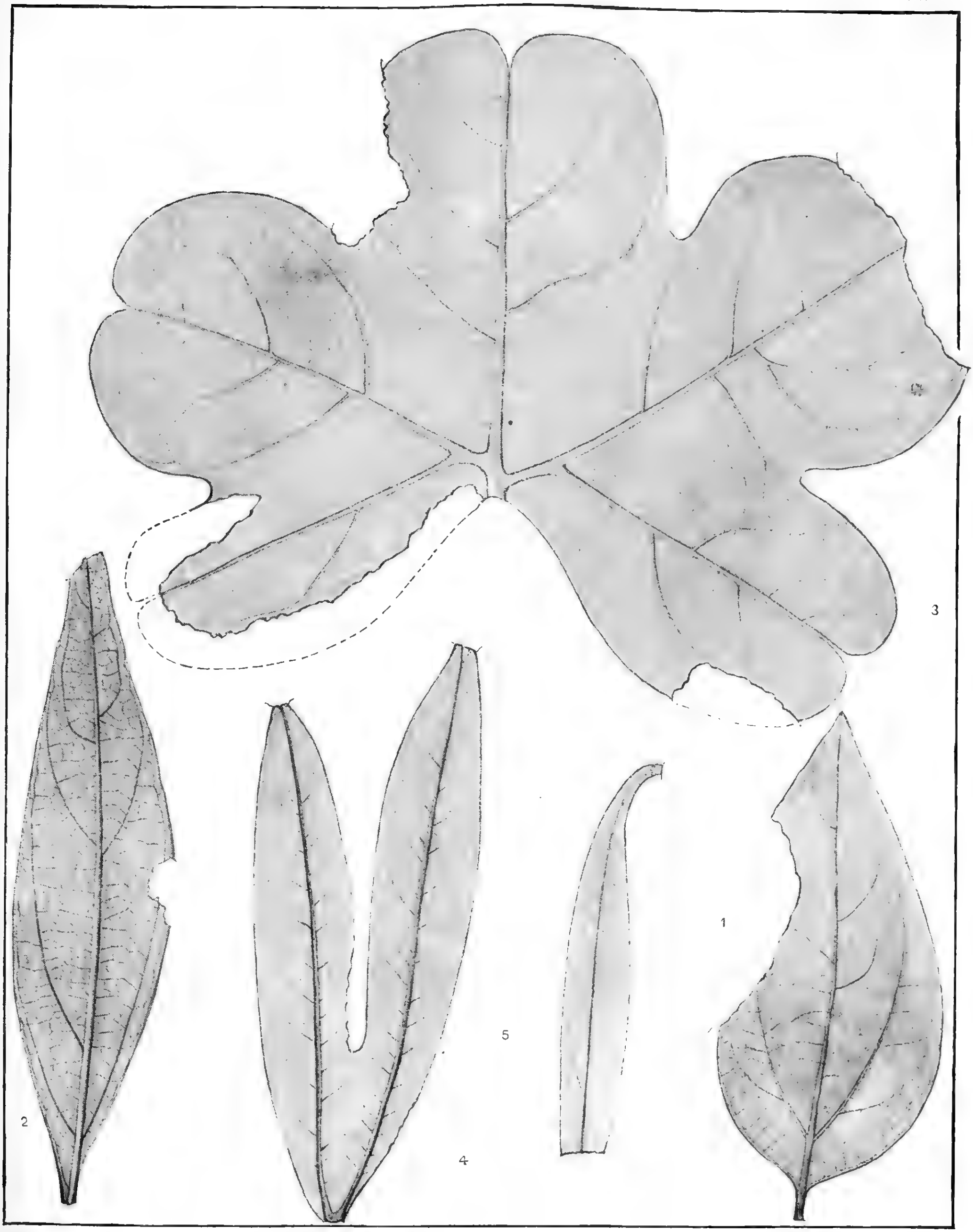
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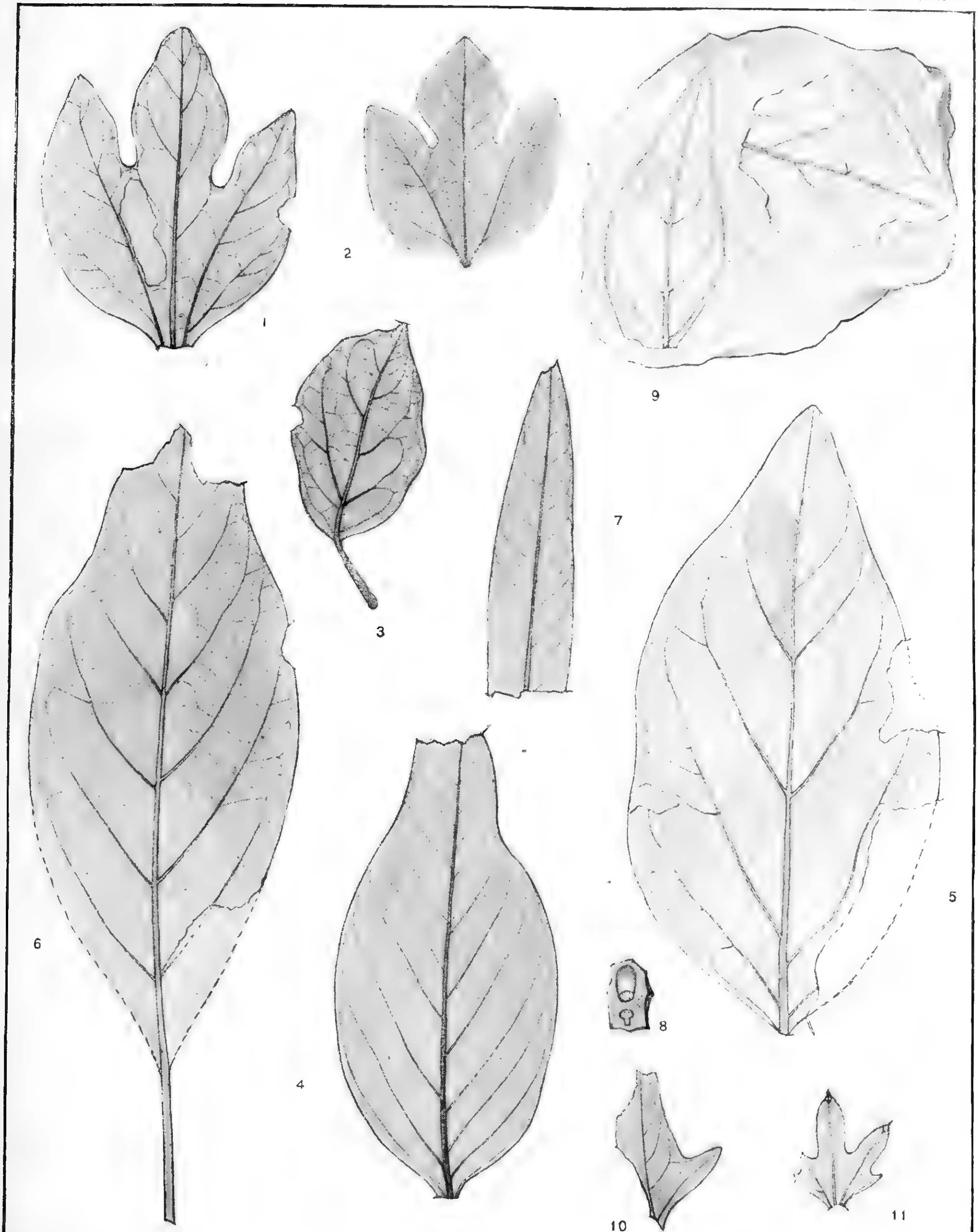
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PLATE XVII.

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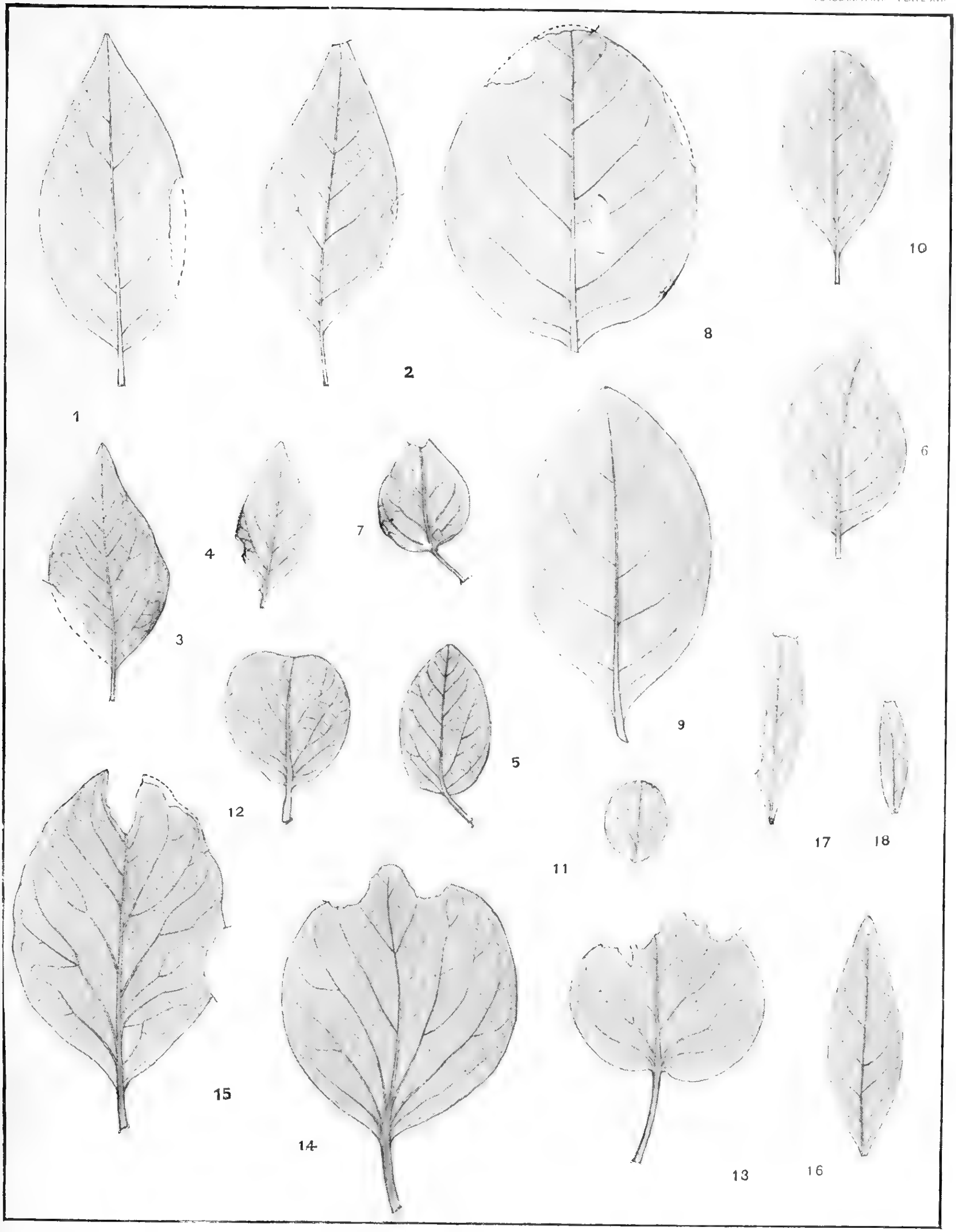
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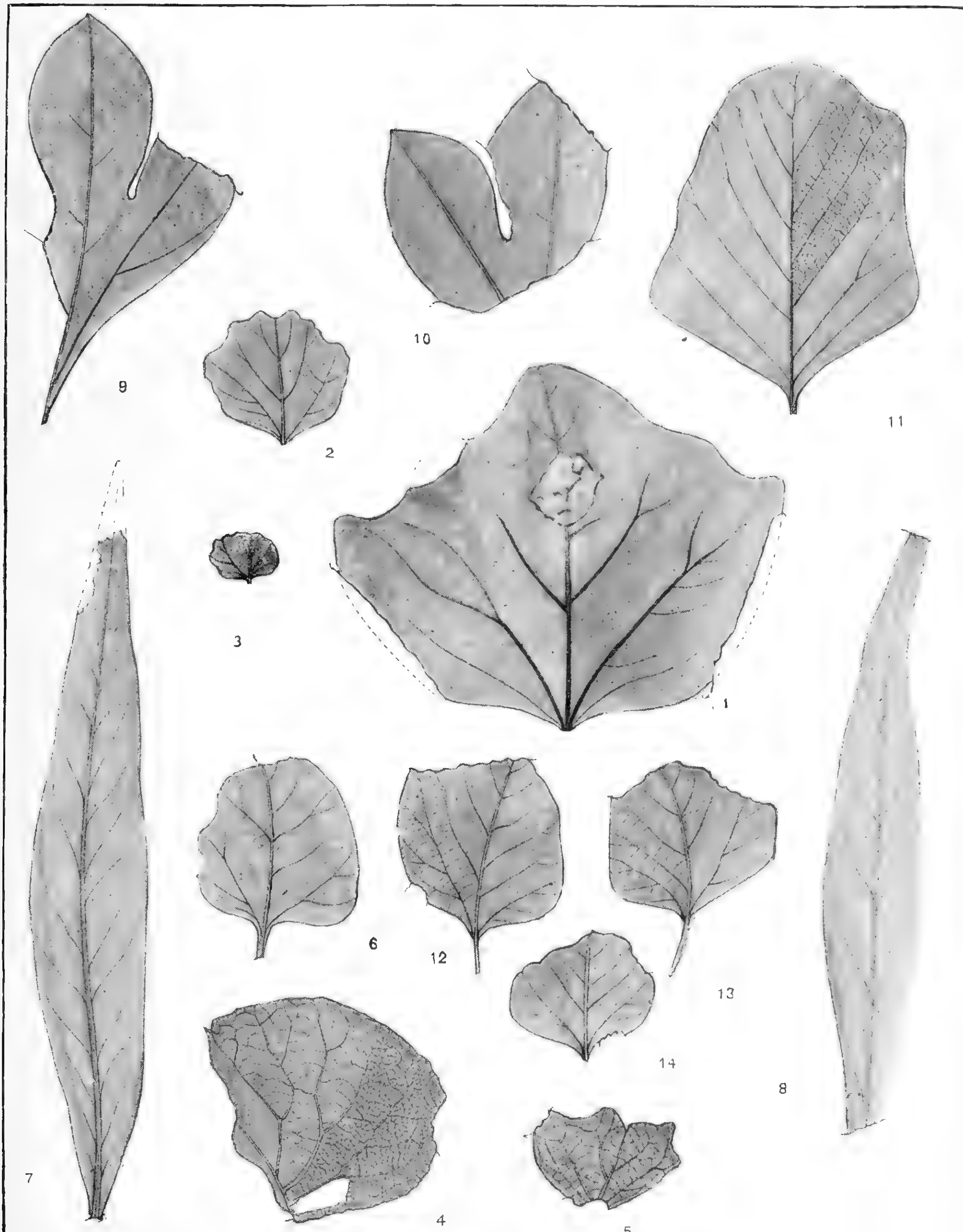

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PLATE XIX.

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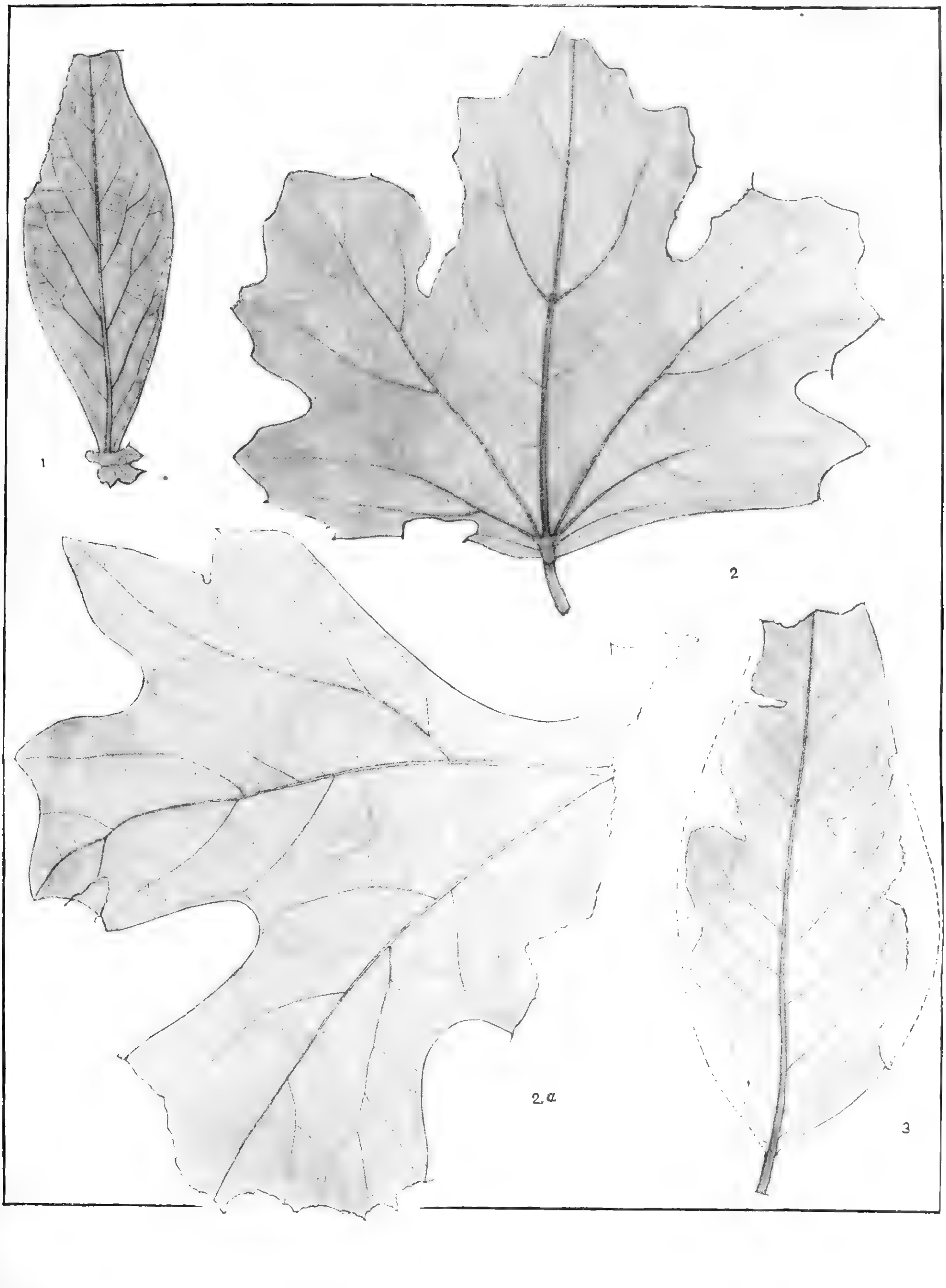
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PLATE XX.

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		Page.
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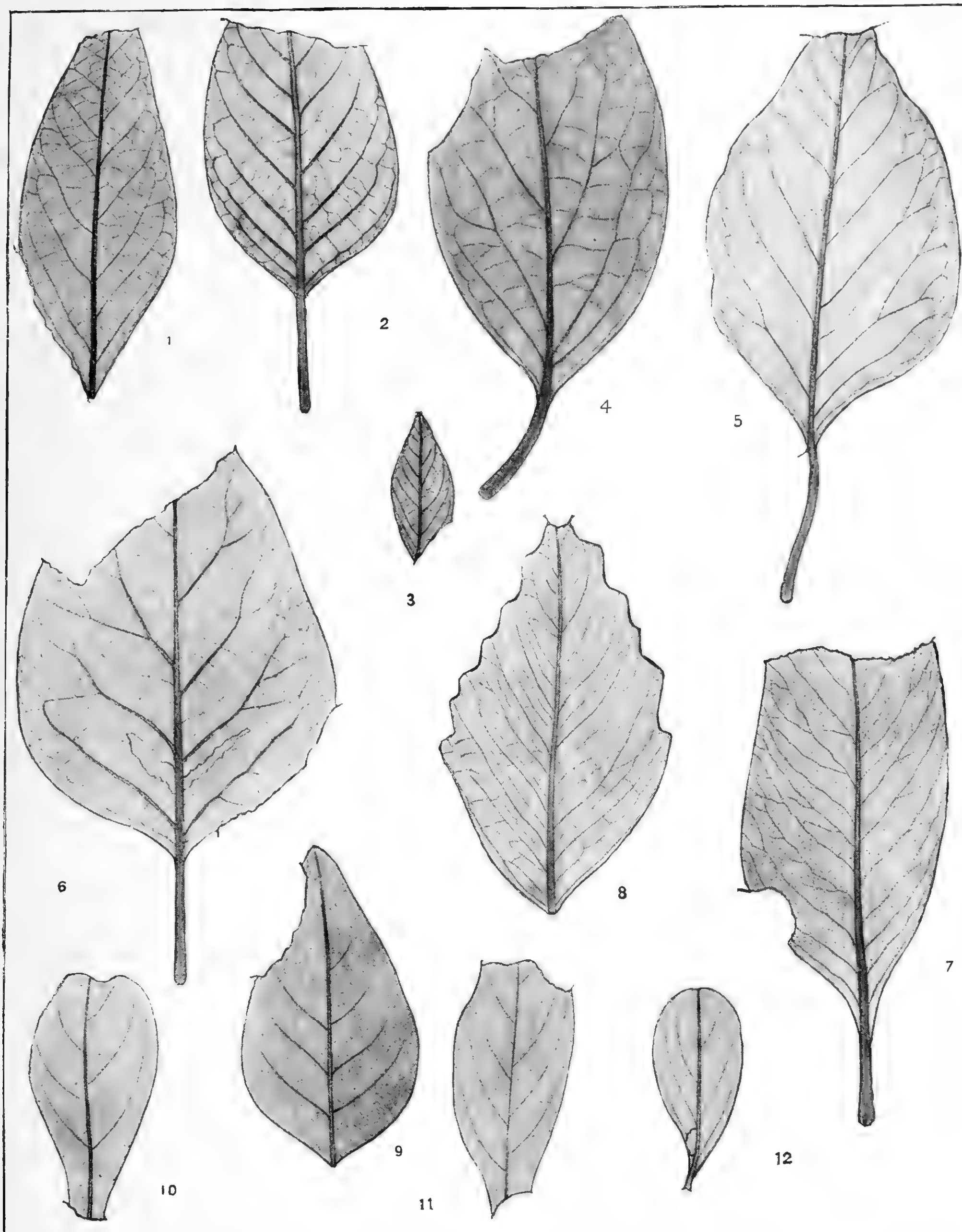
4–6.	Viburnum robustum, sp. nov	120
7.	Diospyros ? celastroides, sp. nov	113
8.	Laurelia primæva, sp. nov	108
9.	Phyllites Vanonæ Heer	214
10–12.	Persoonia Lesquereuxii Knowlton, sp. nov	89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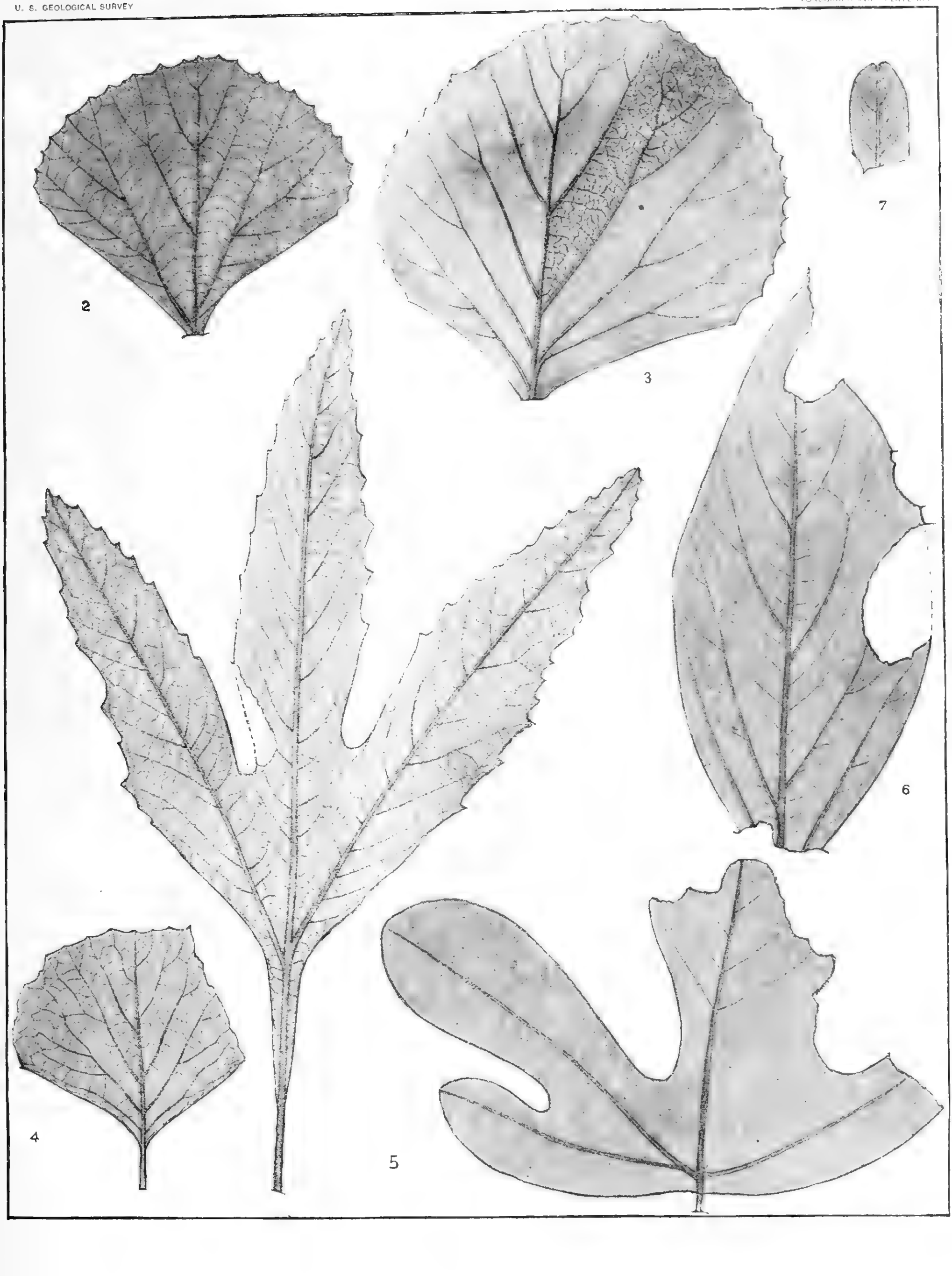
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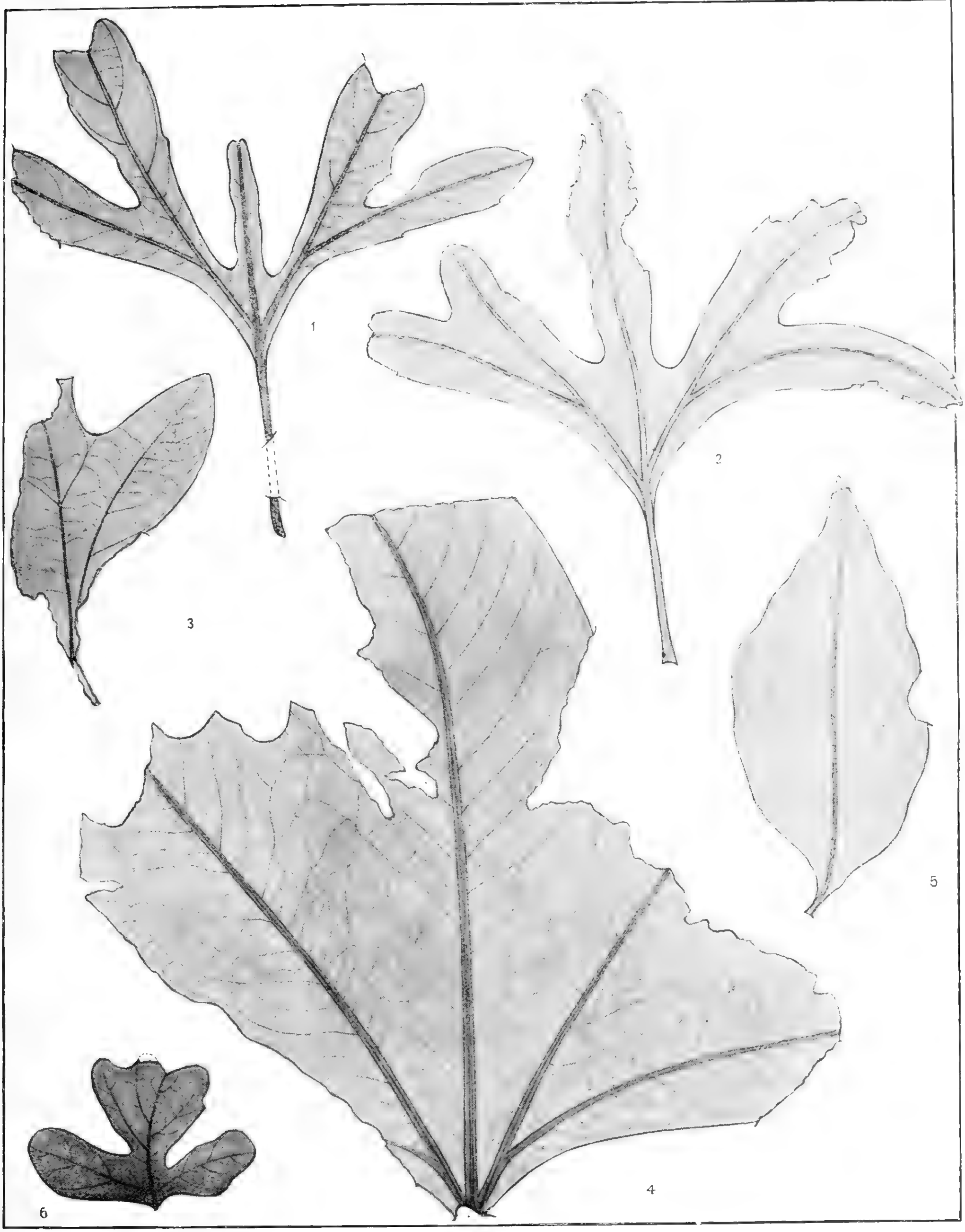
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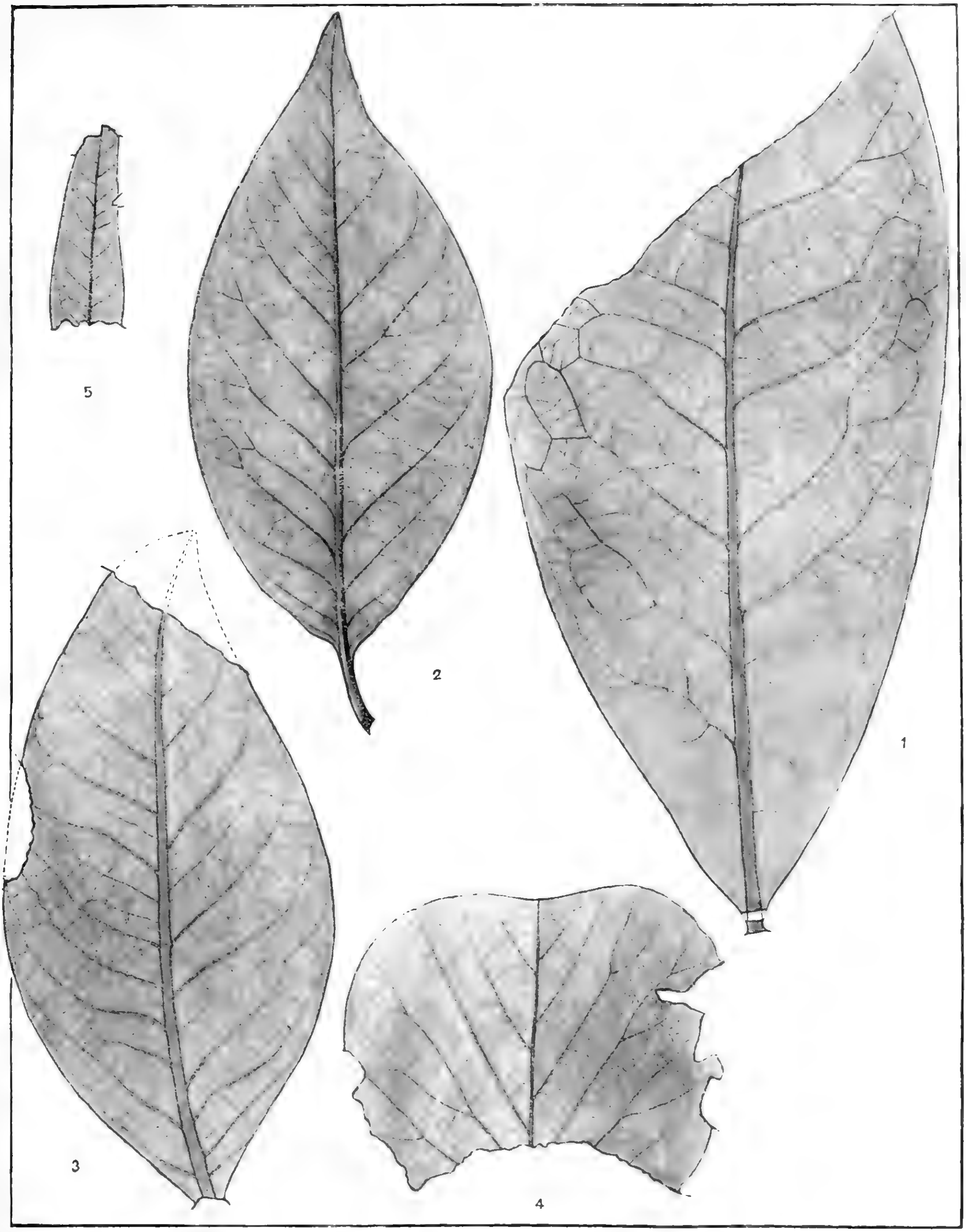

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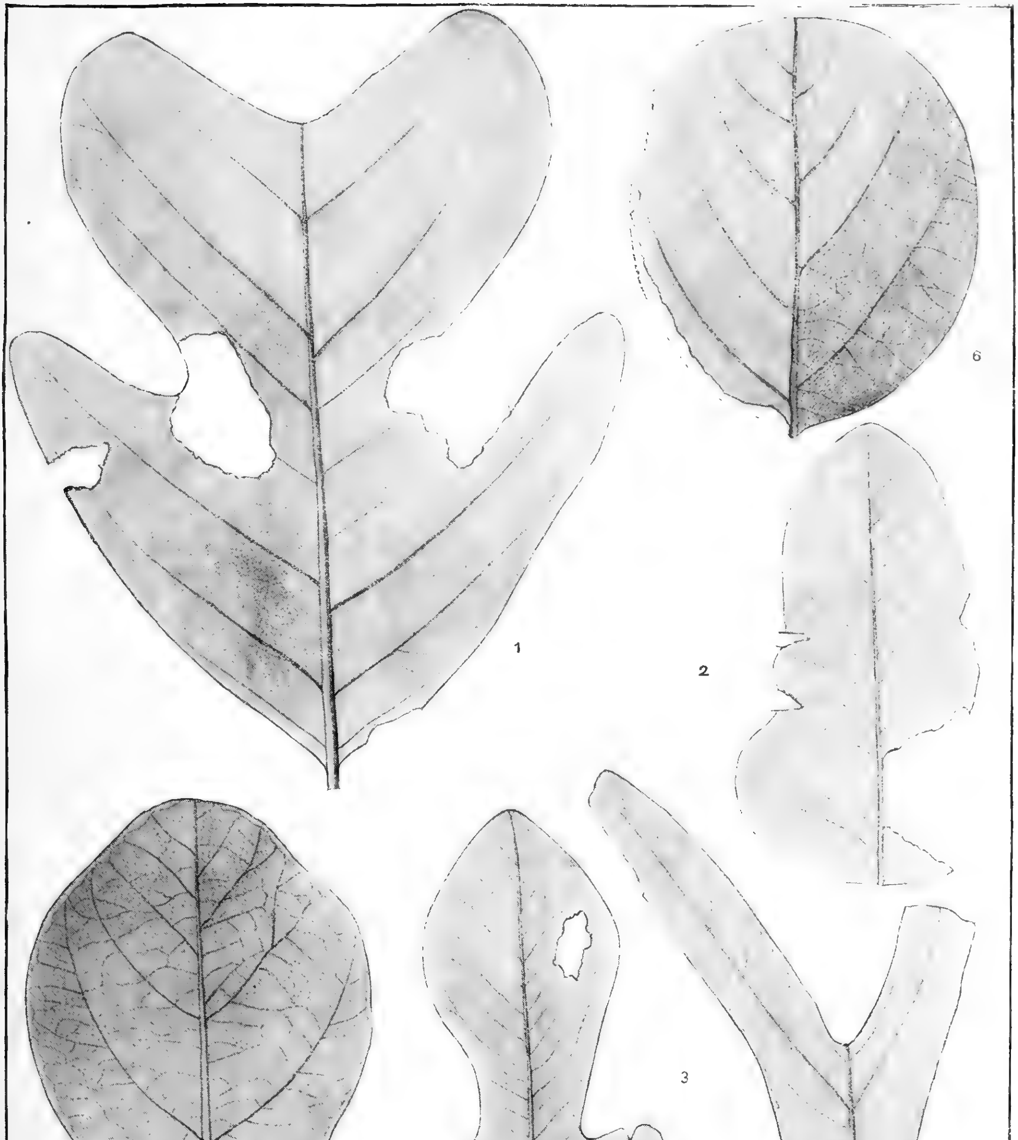
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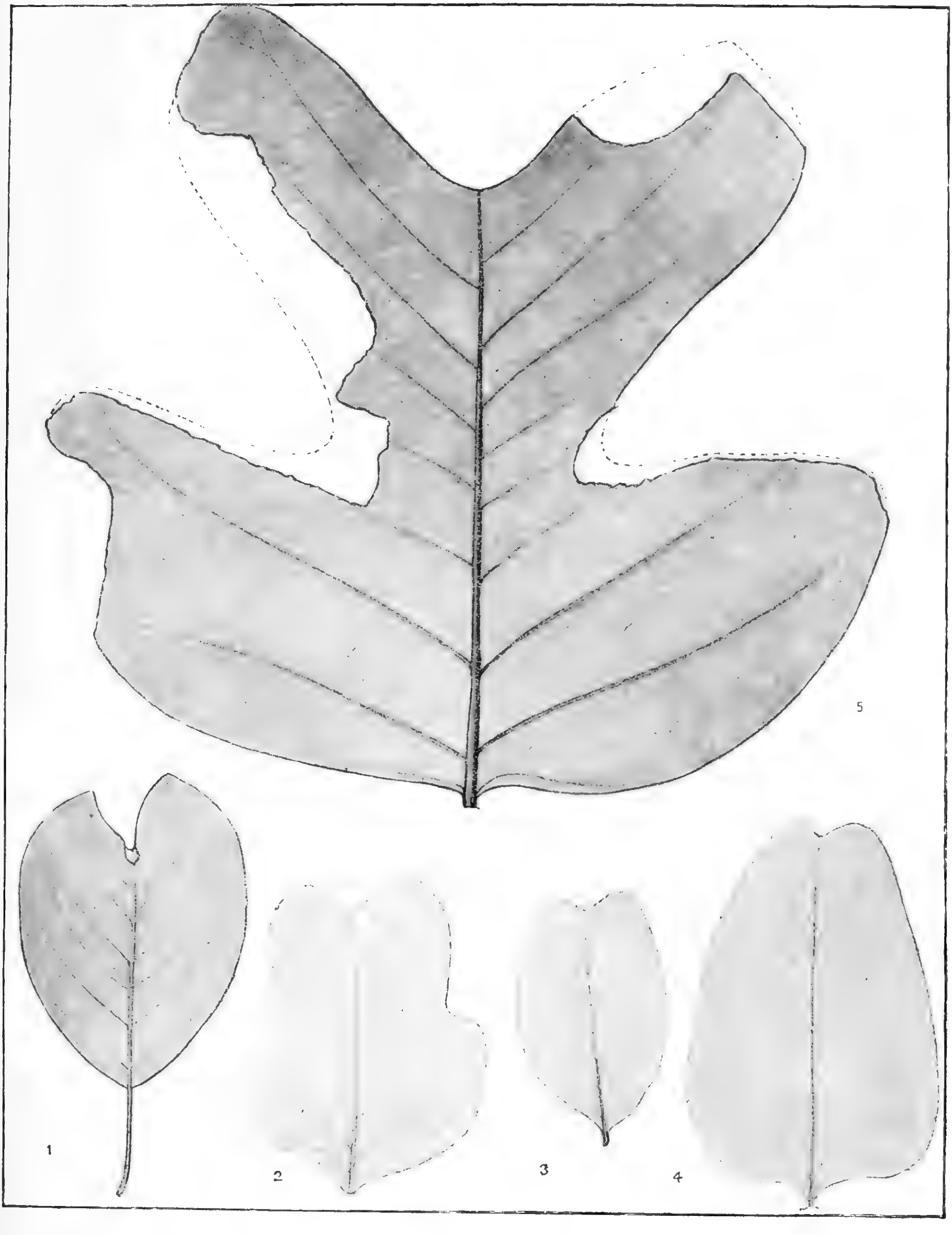
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PLATE XXVII.

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		Page.
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2, 3.	Liriodendron acuminatum Lesq	207
4, 5.	Liriodendron pinnatifidum Lesq	209

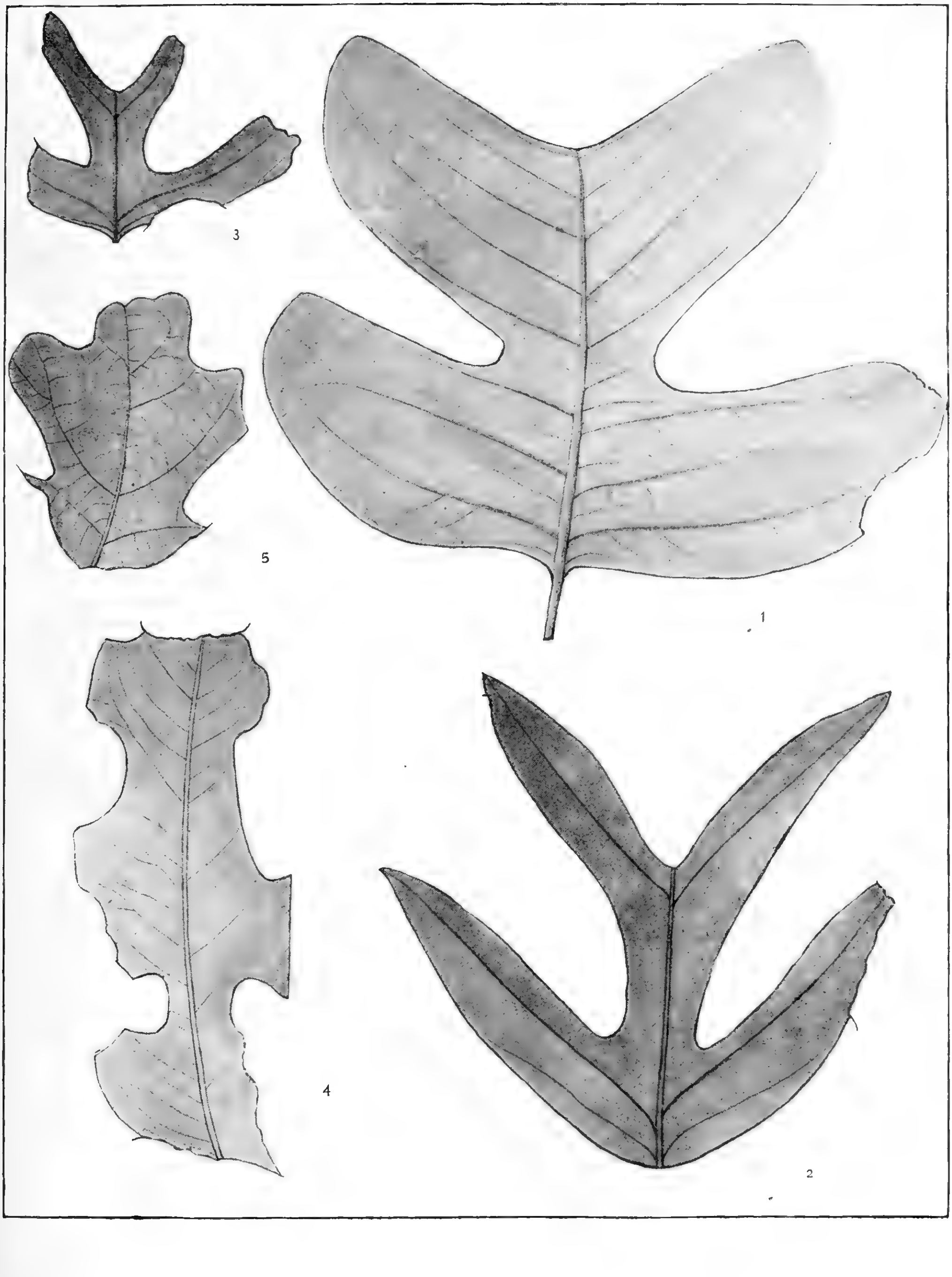
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PLATE XXVIII.

PLATE XXVIII.

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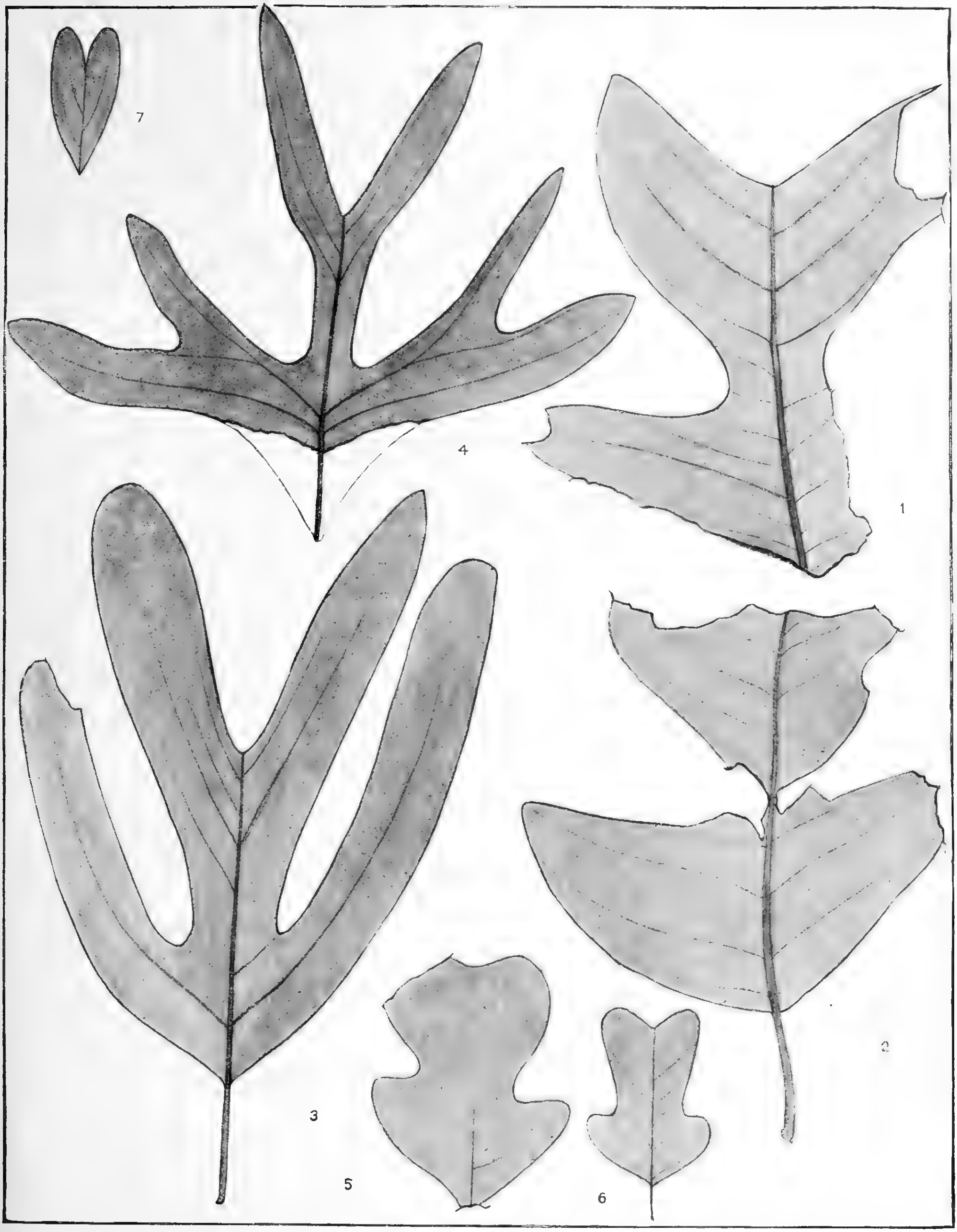
4.	Liriodendron acuminatum var. bilobatum, n. var	207
5, 6.	Liriodendron Meekii Heer	205
7.	Liriophyllum obcordatum Lesq	210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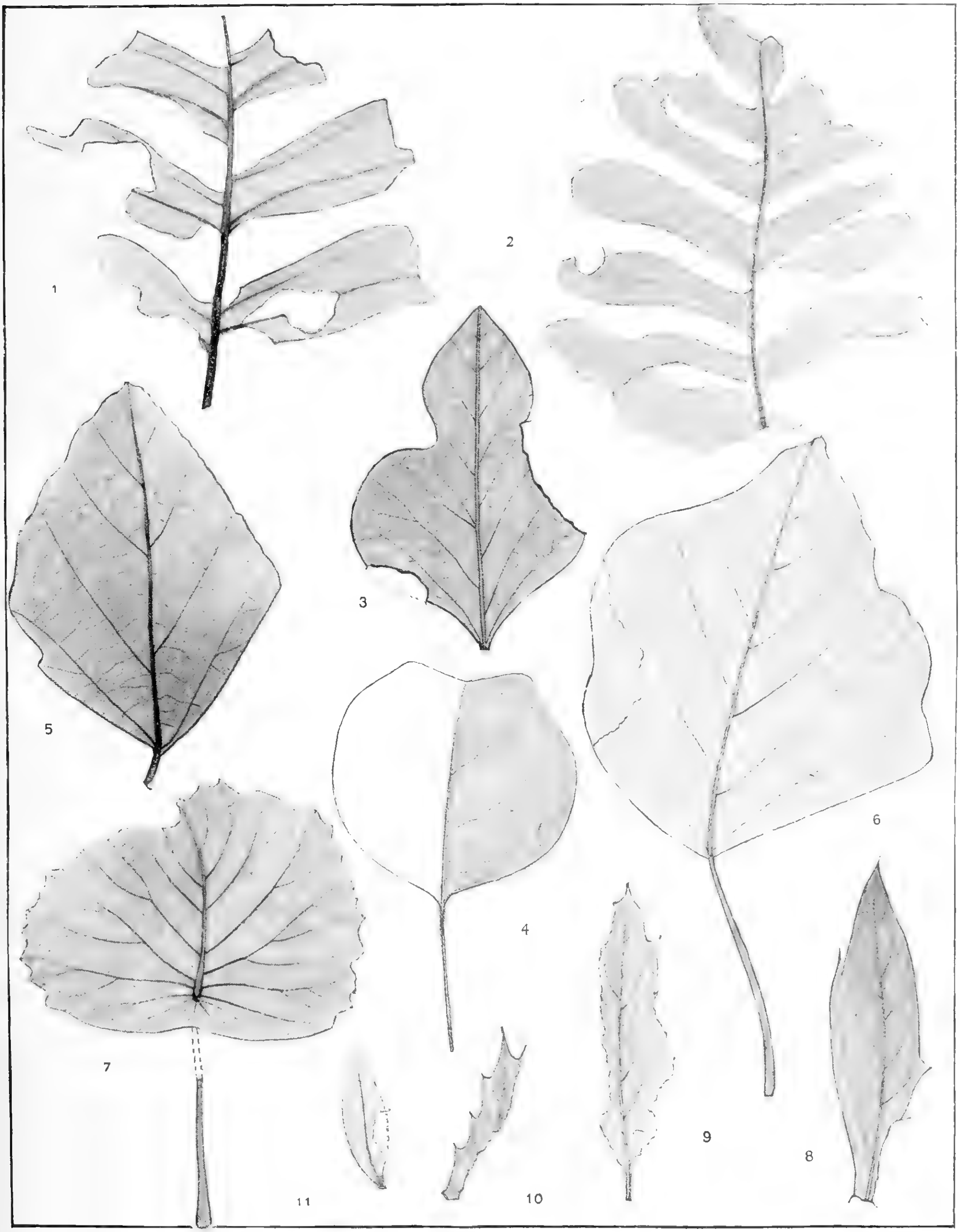
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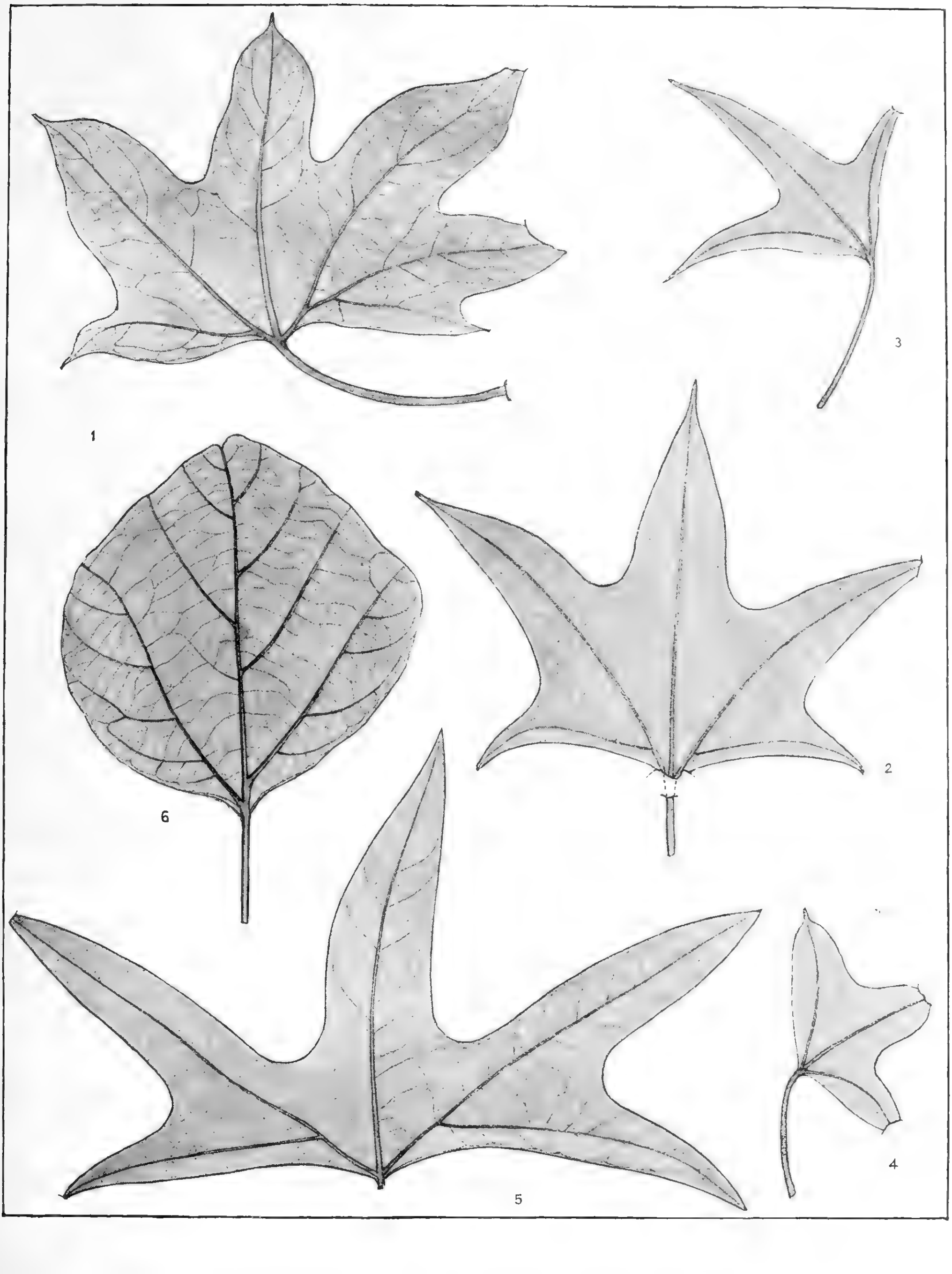
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PLATE XXXI.

PLATE XXXI.

		Page.
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2a.	Sphæria problematica Knowlton, sp. nov.	23
3.	Sterculia Snowii? sp. nov.	183


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PLATE XXXII.

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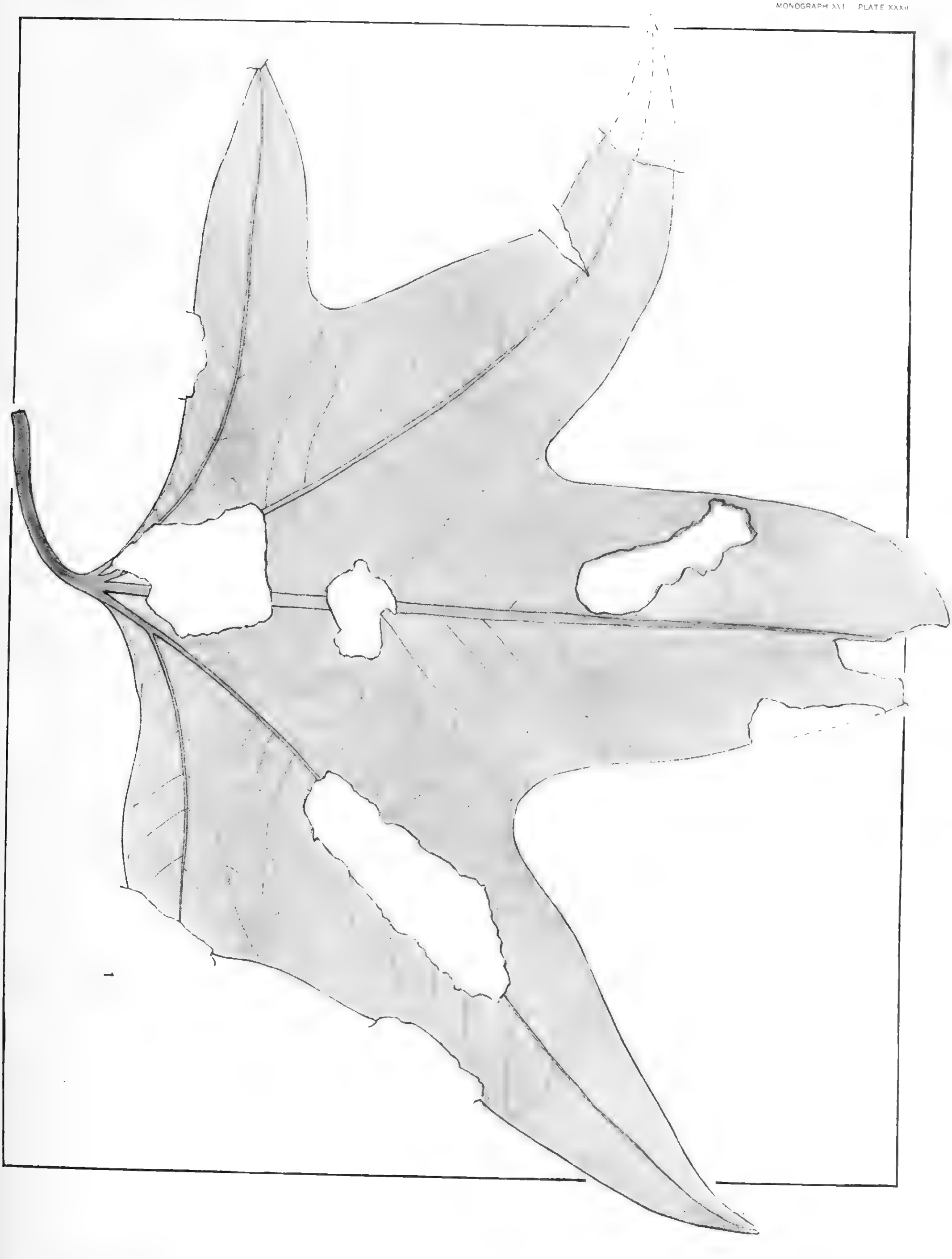

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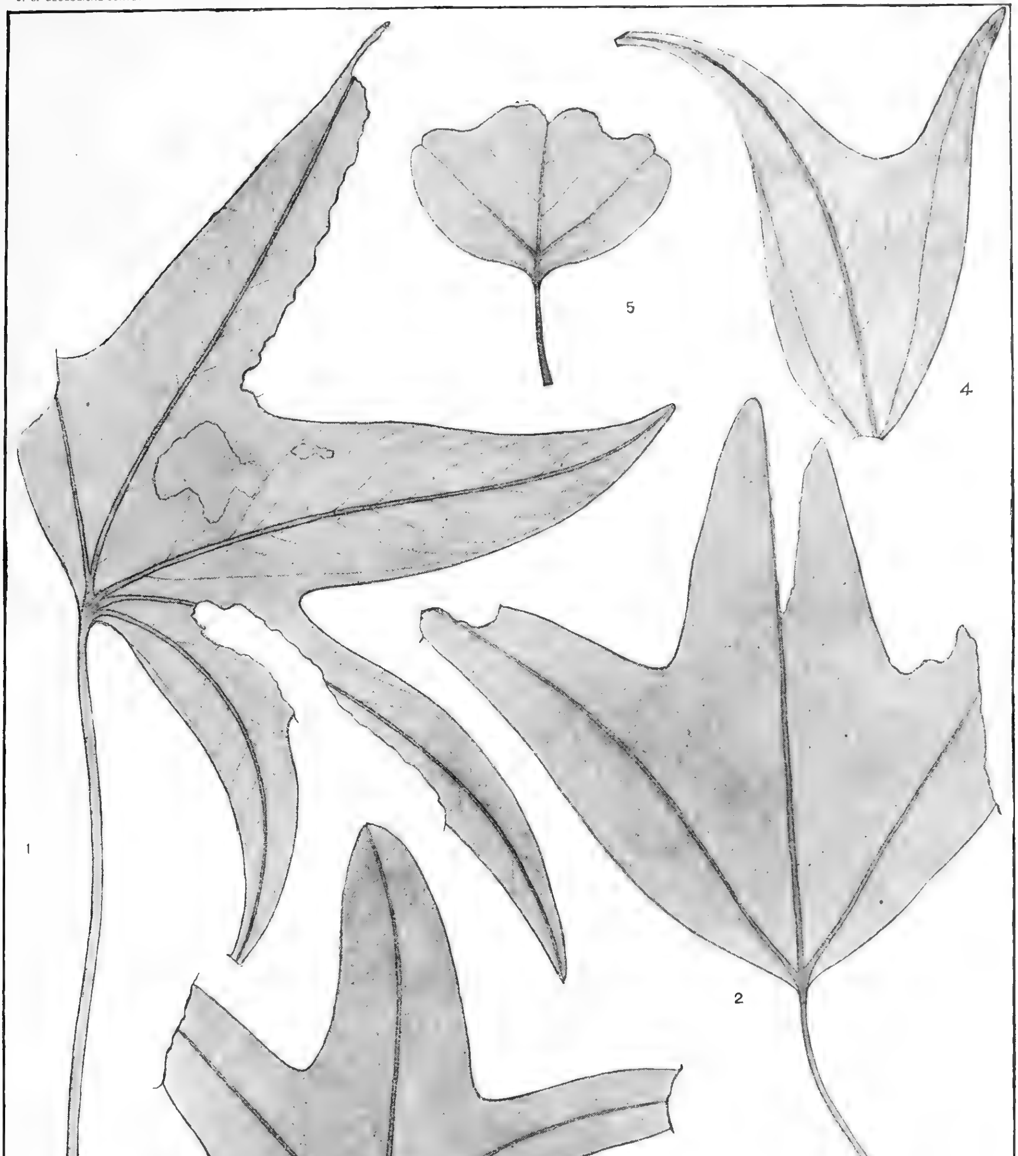
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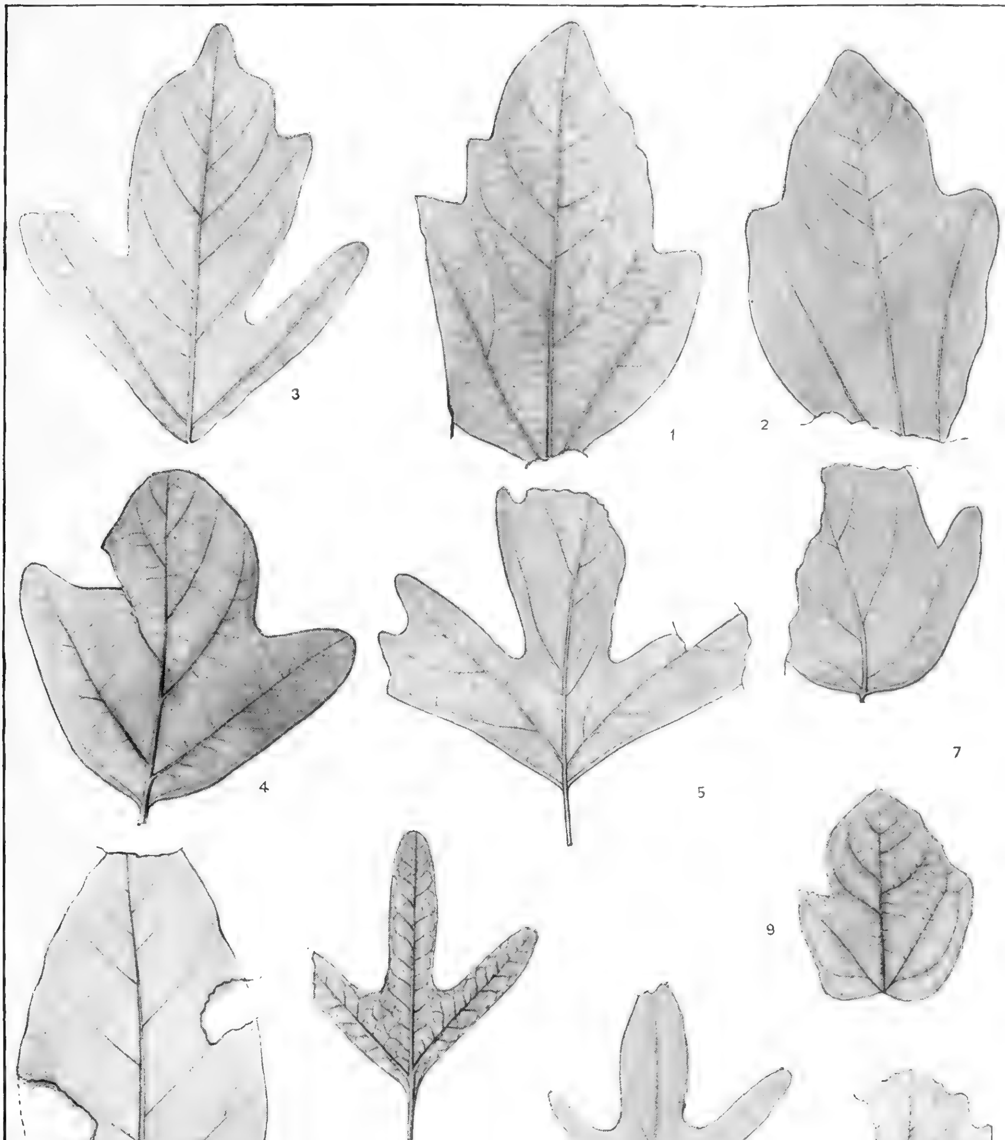
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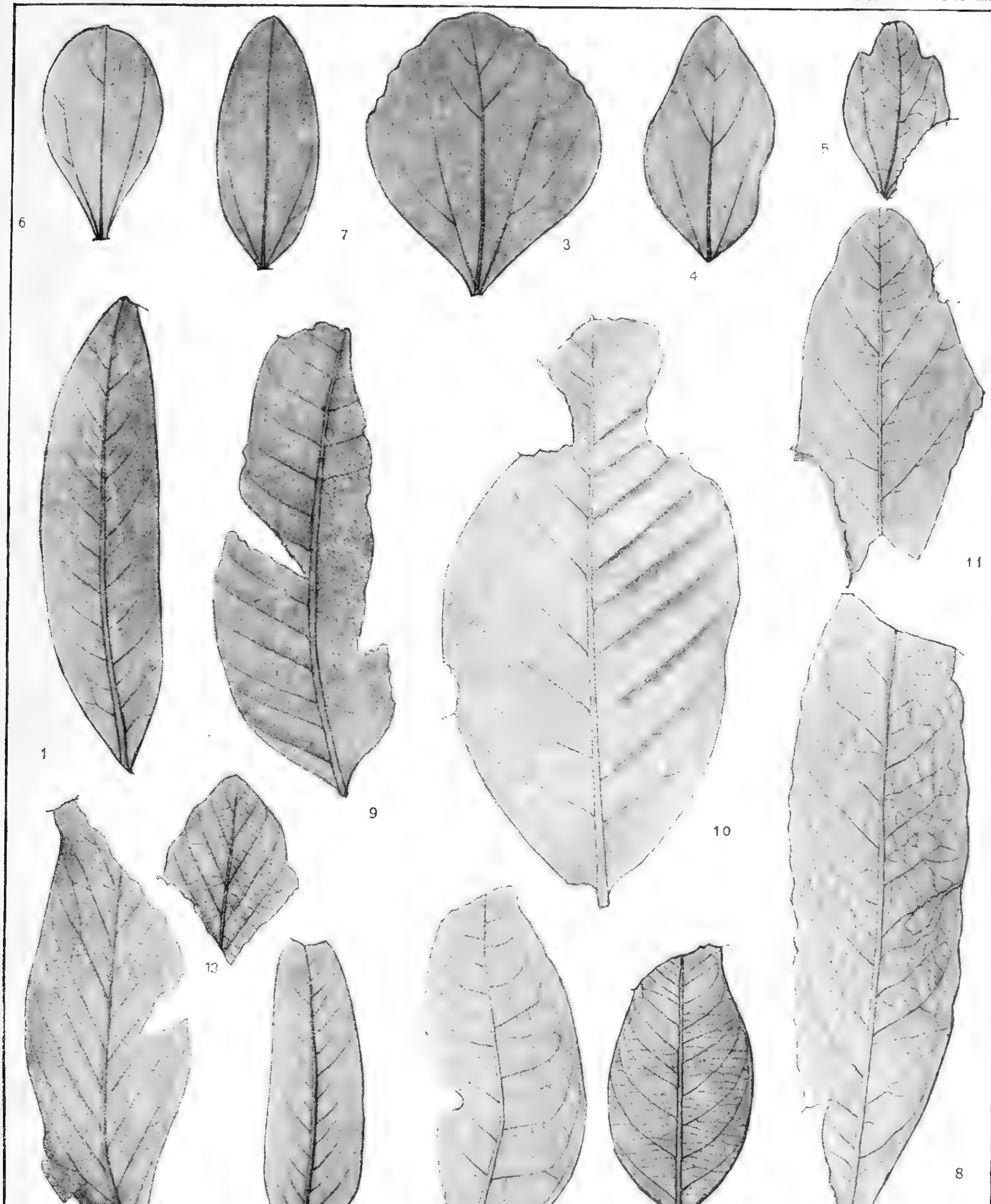
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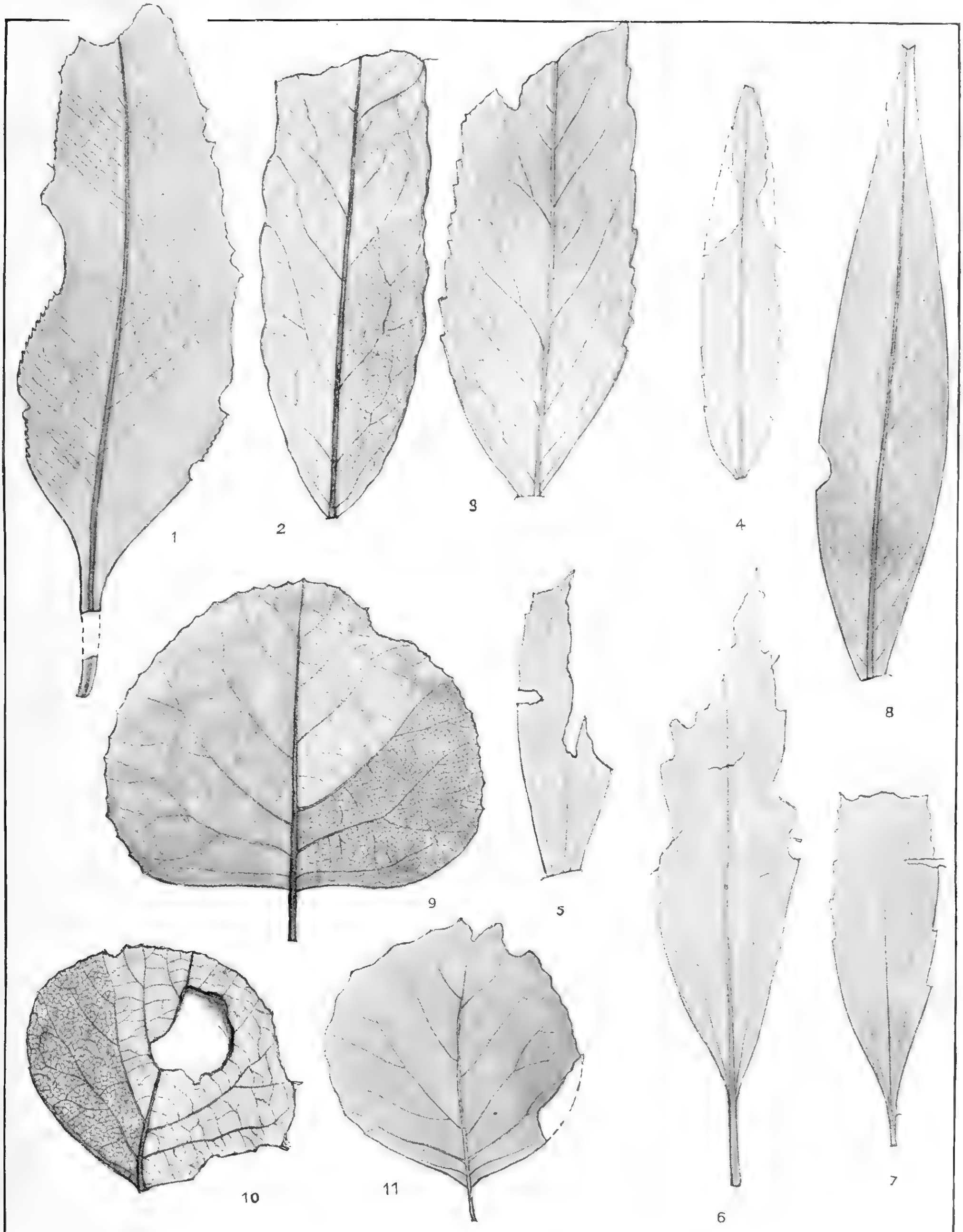
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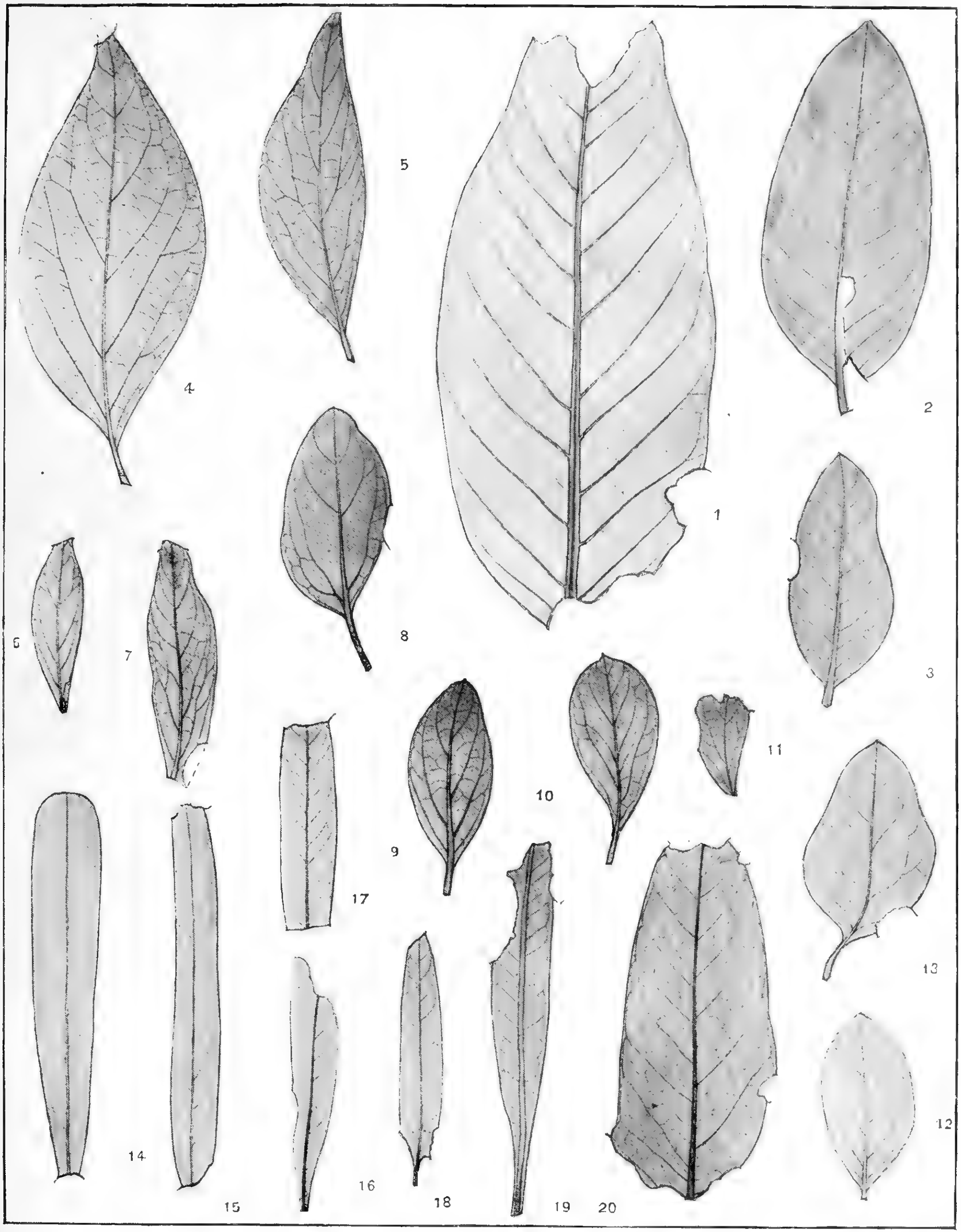
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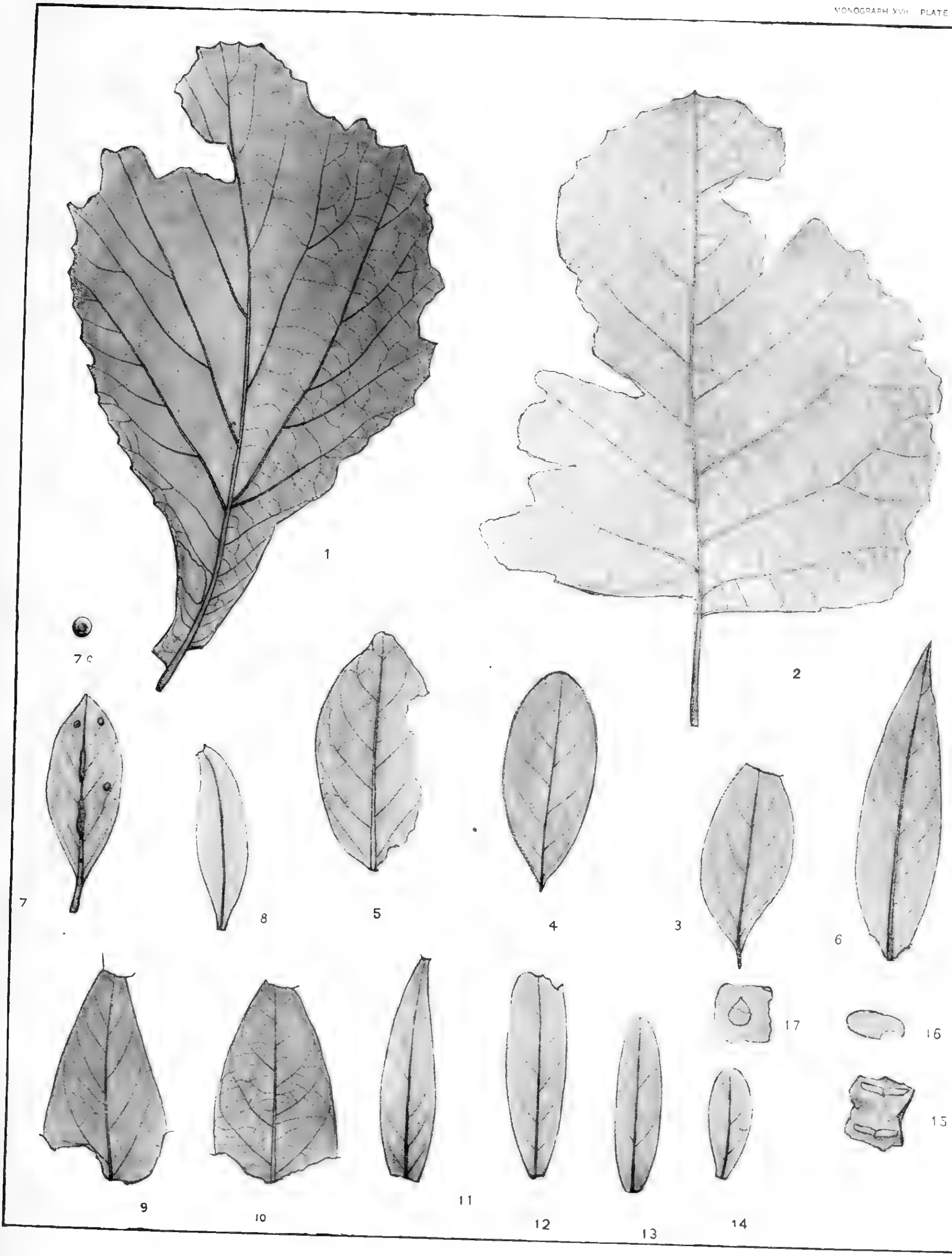
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PLATE XXXIX.

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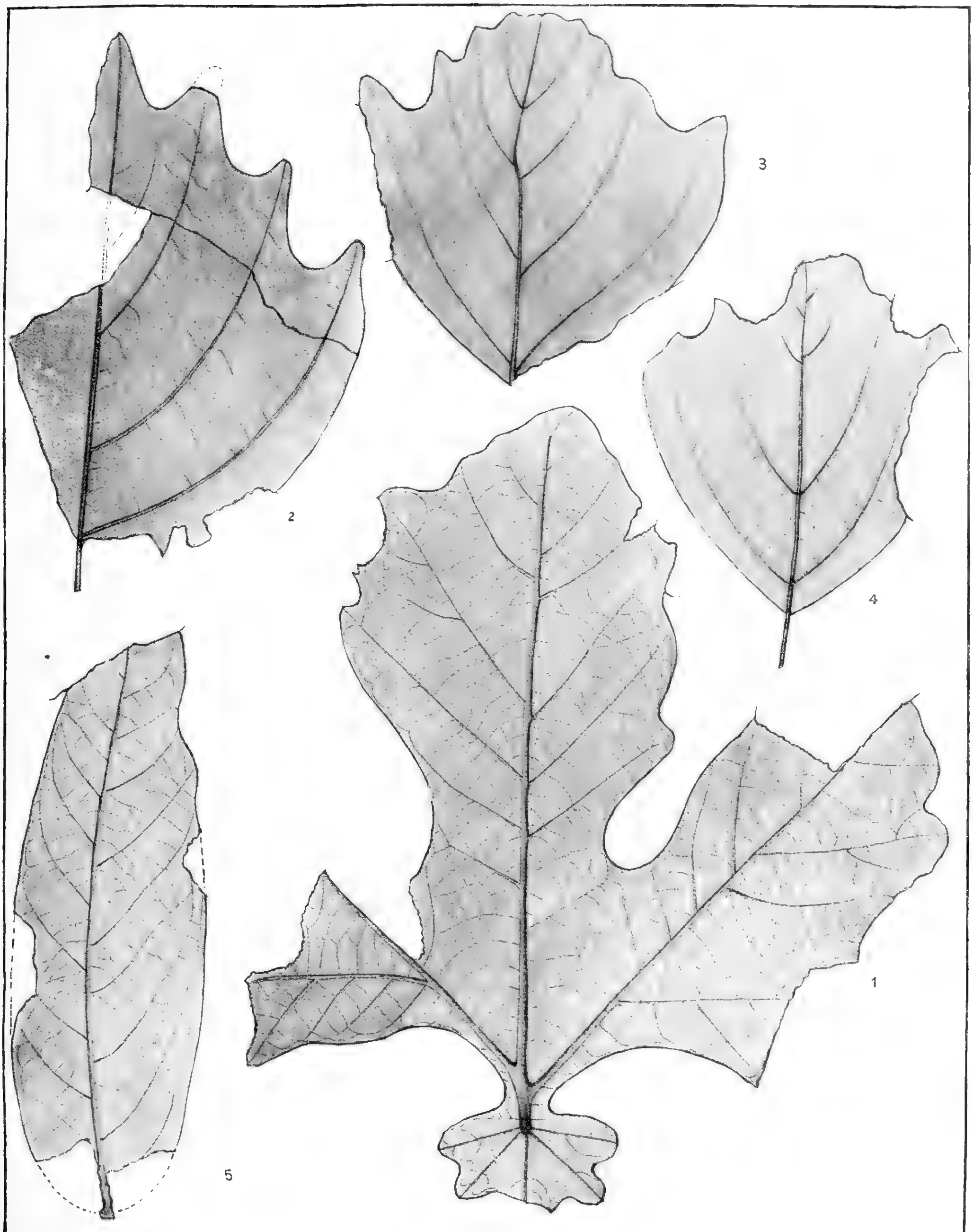

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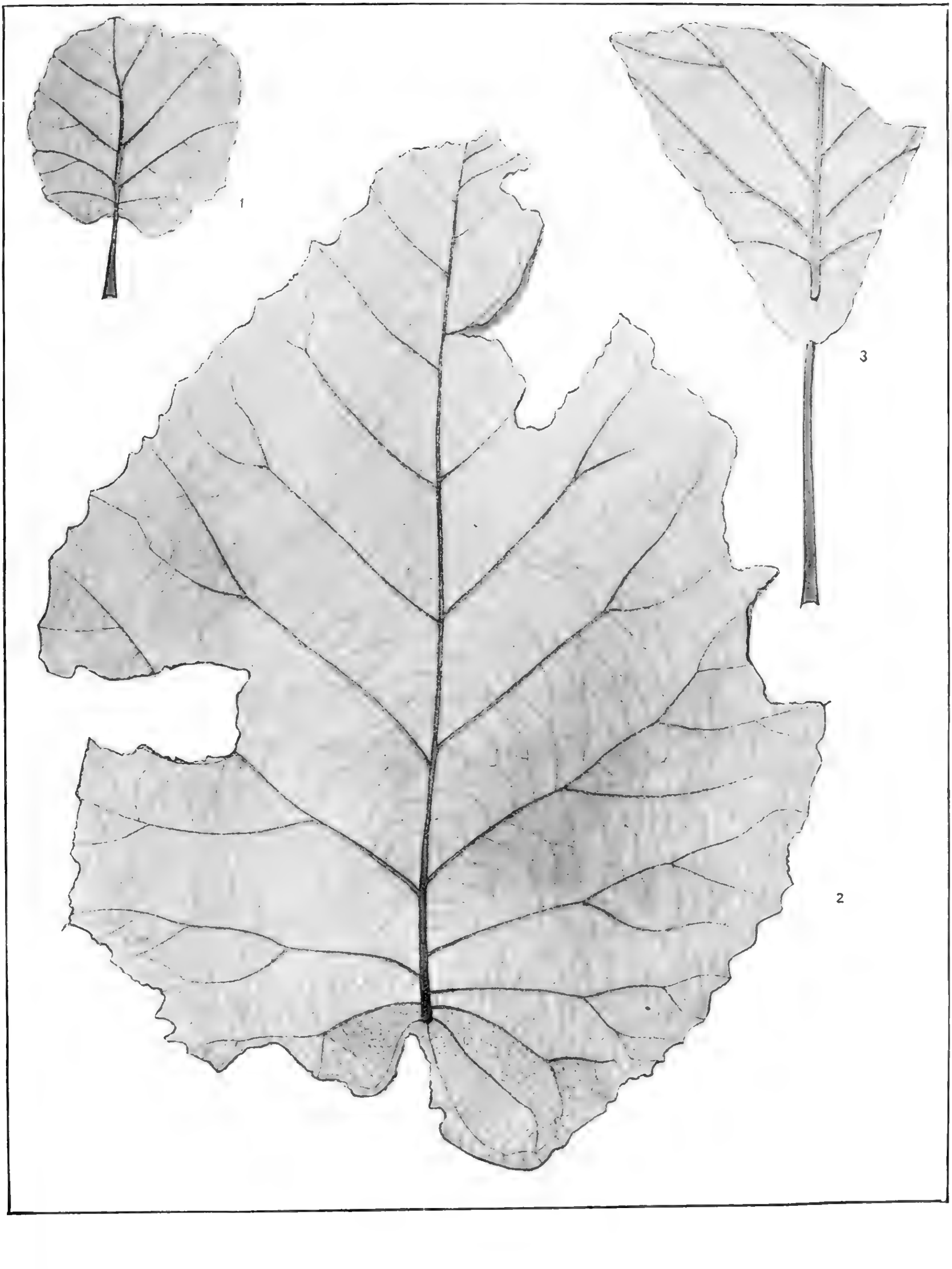
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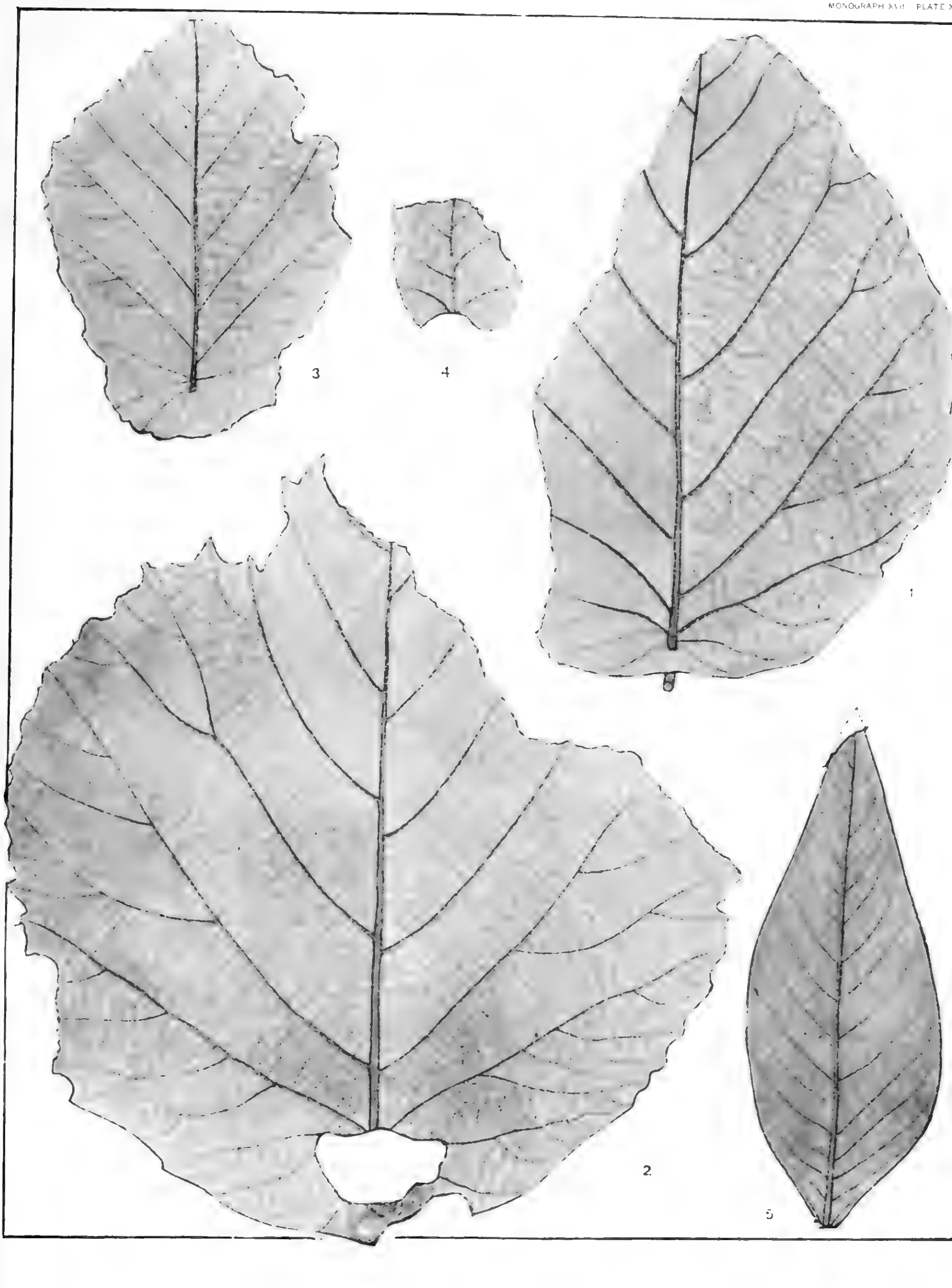
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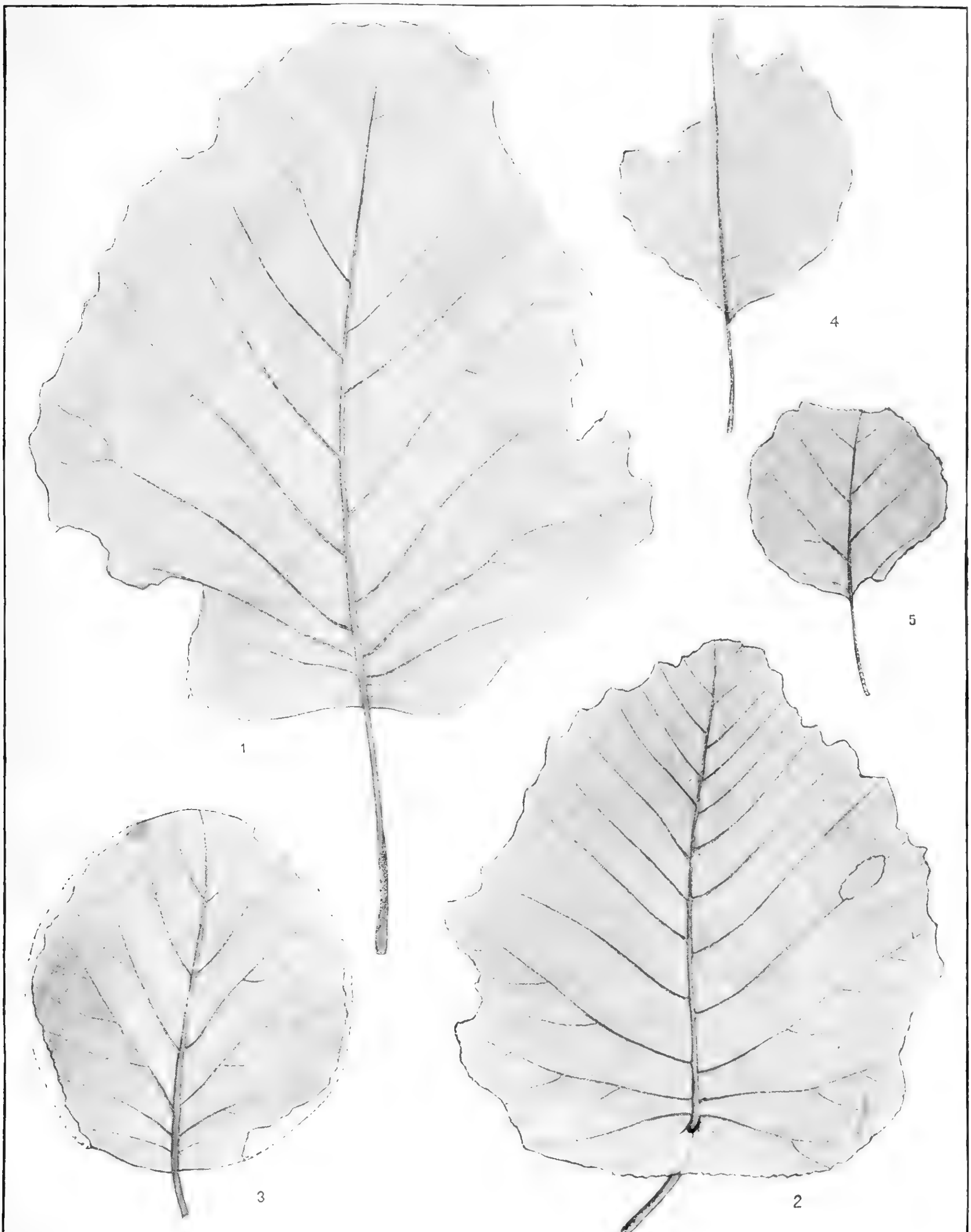
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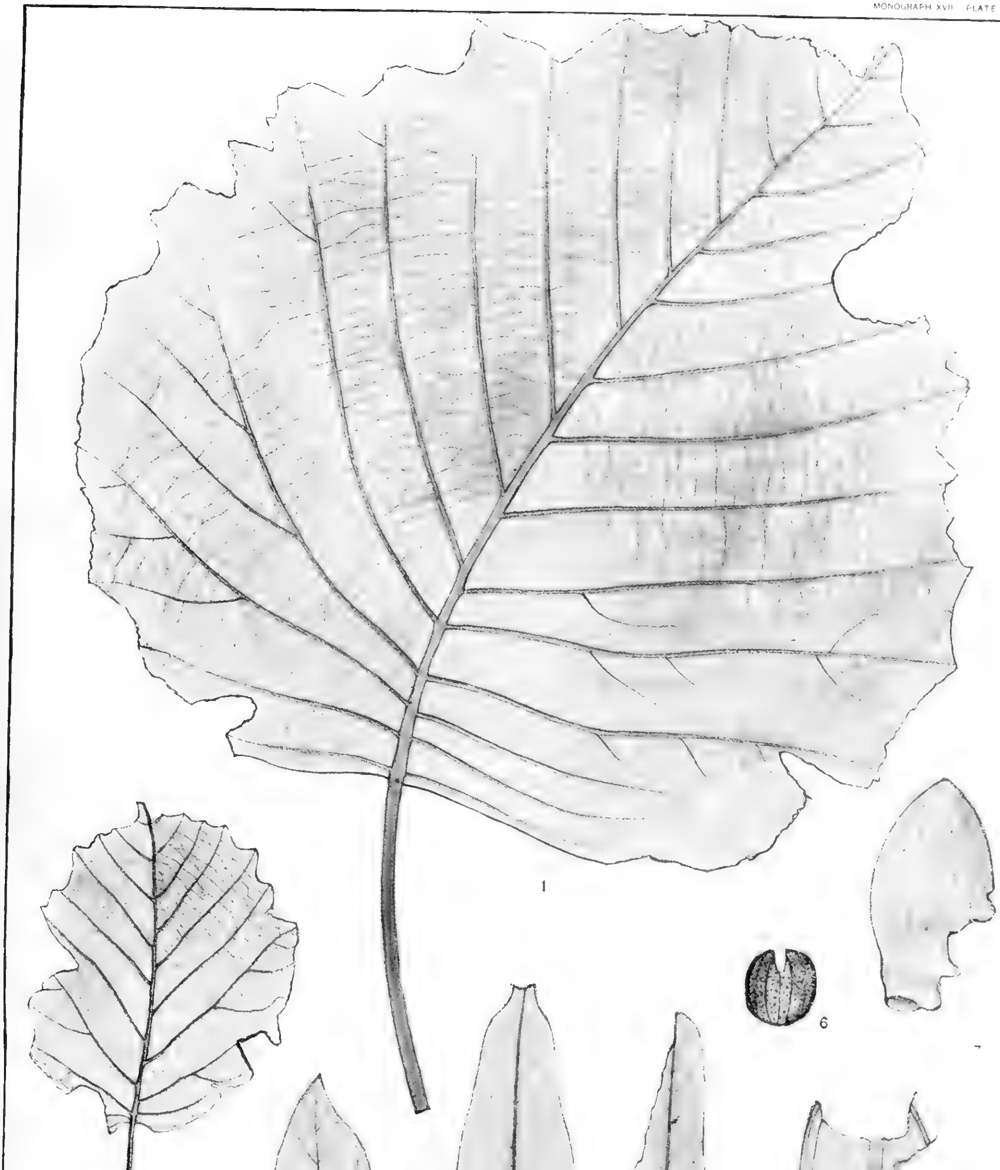
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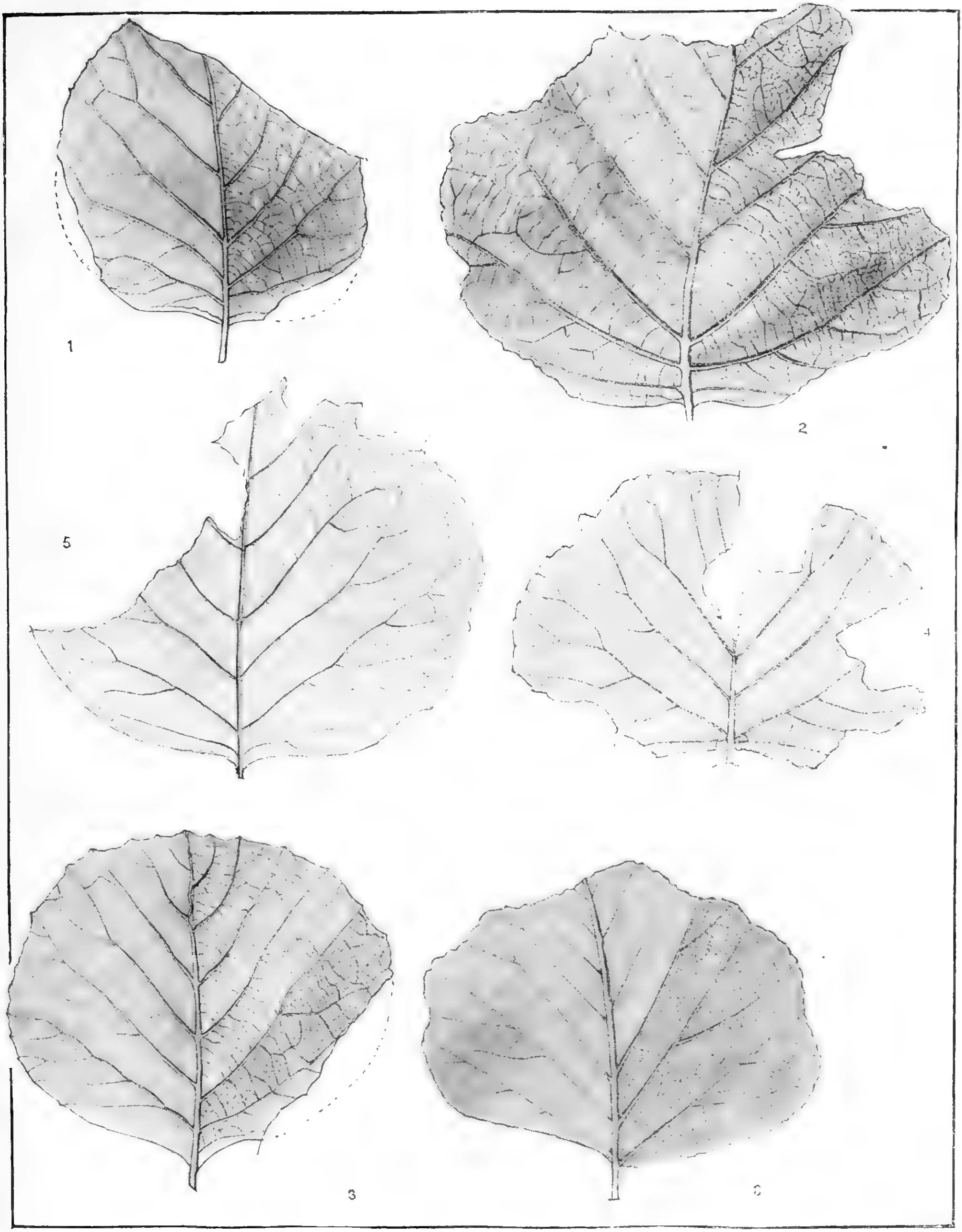
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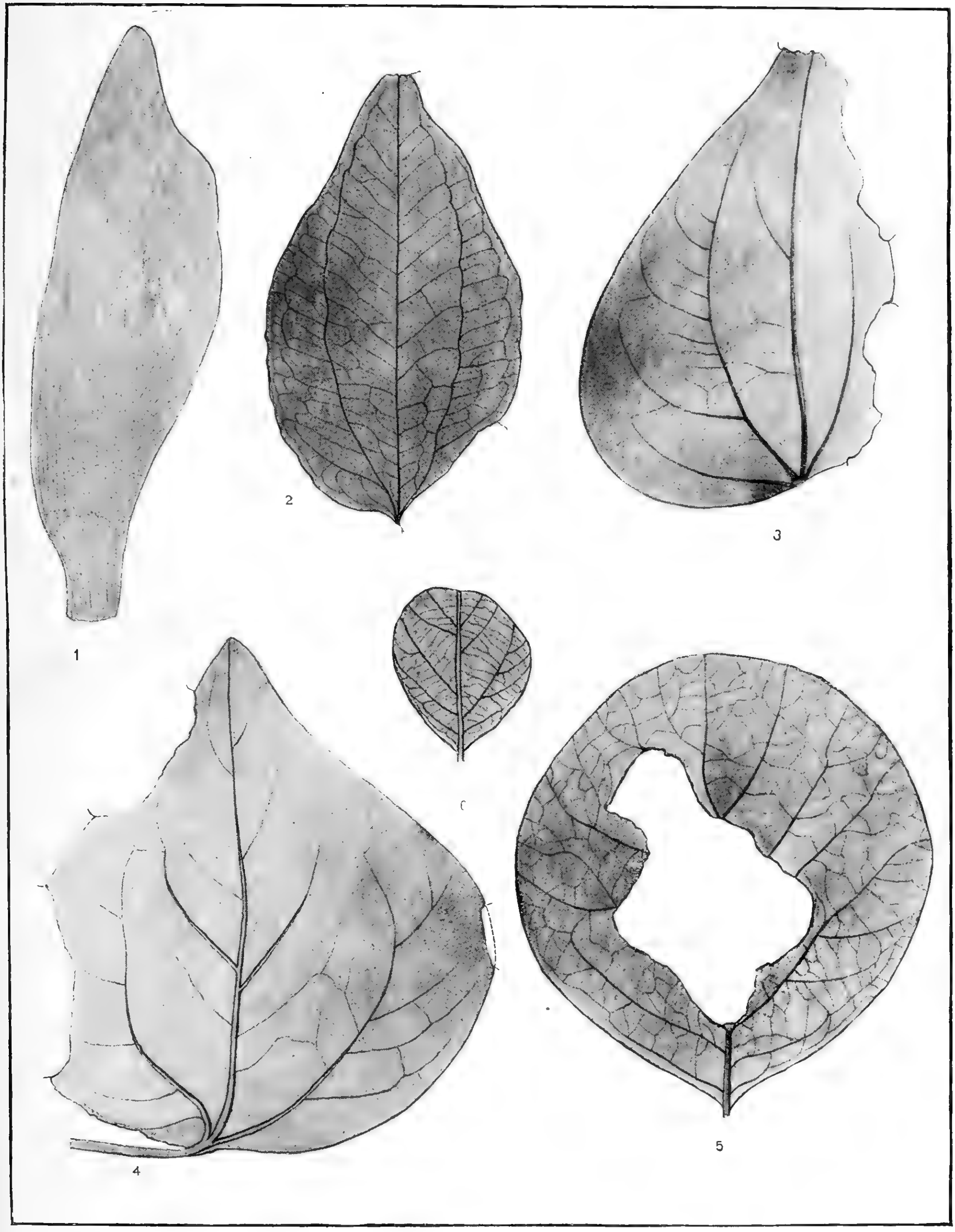
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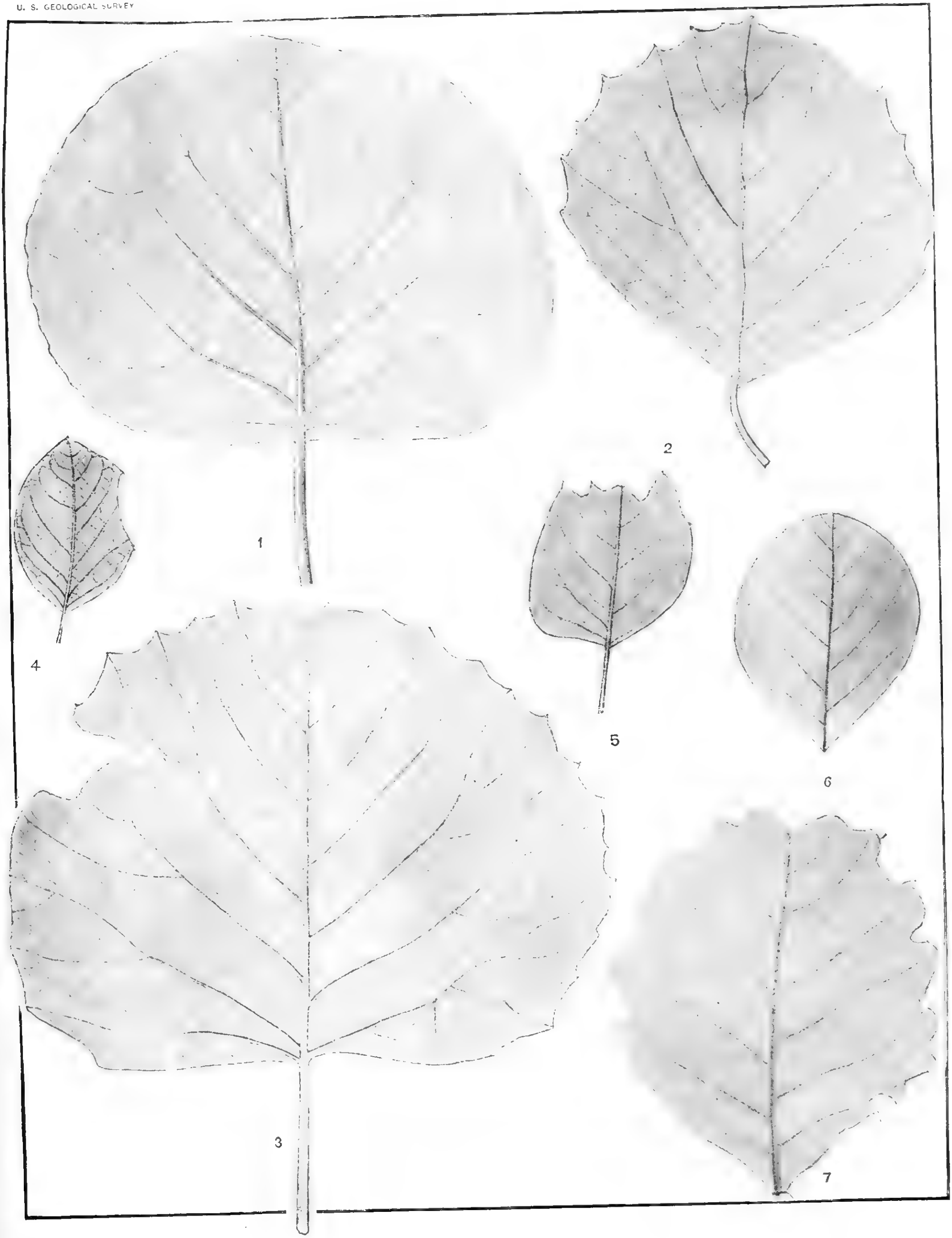
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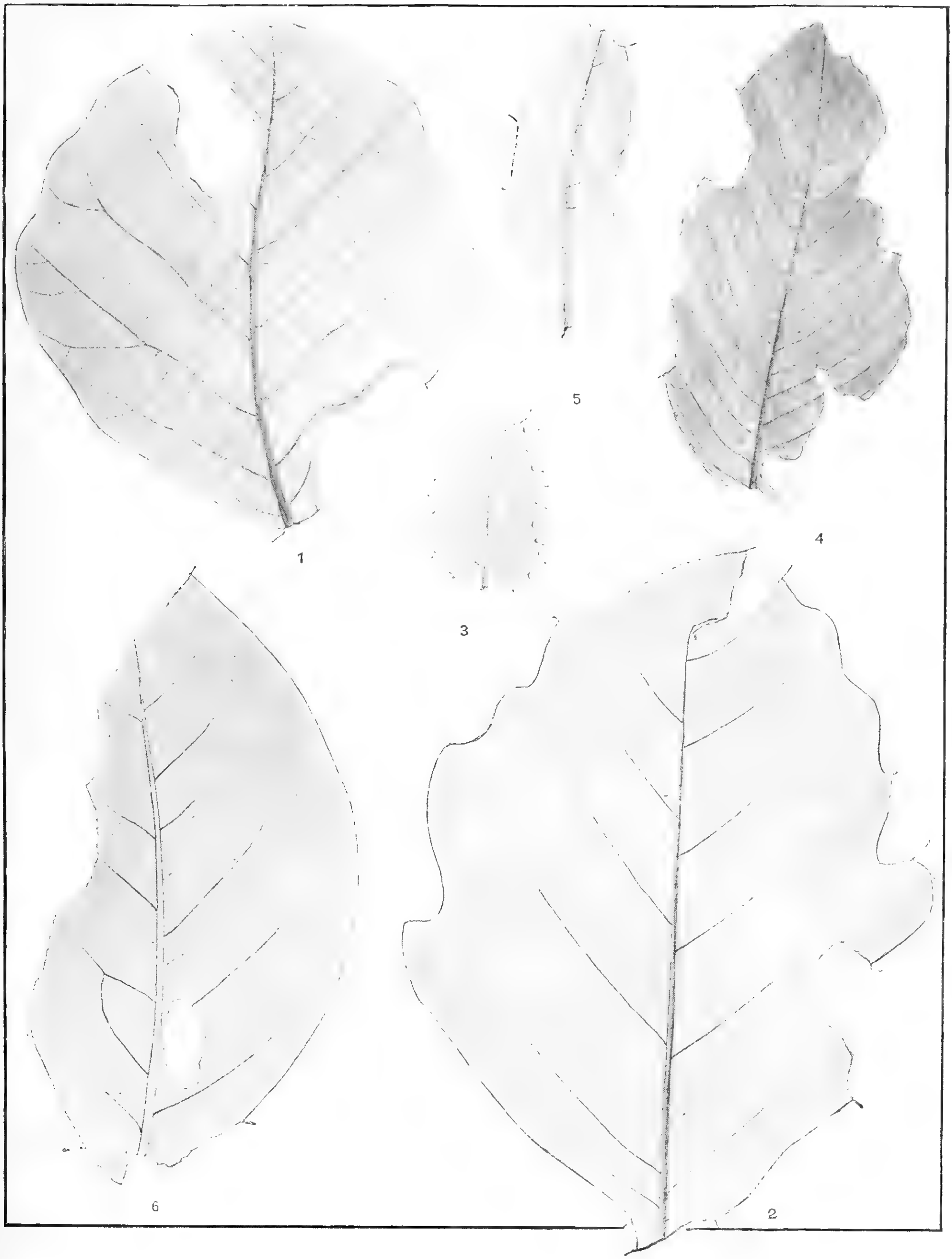
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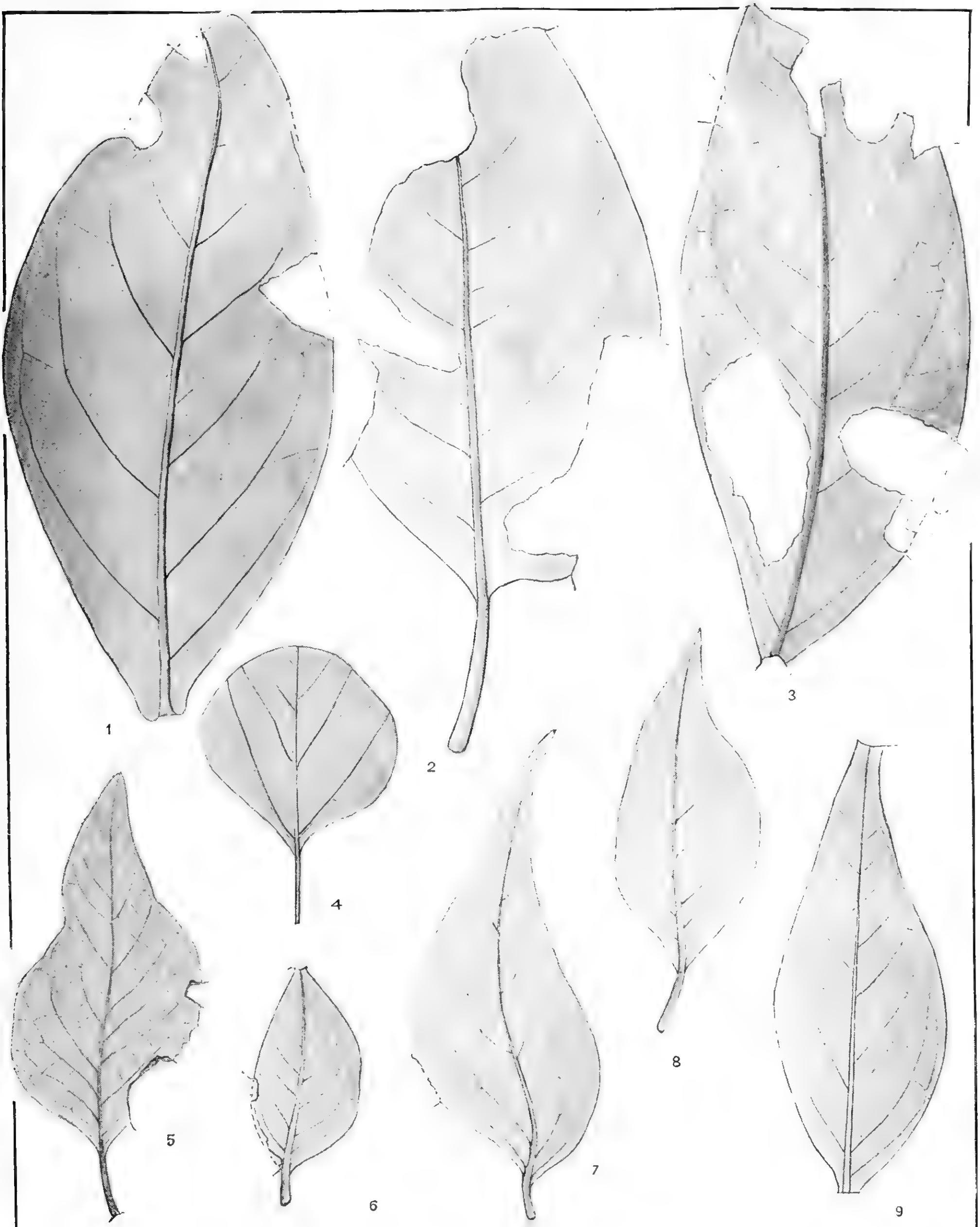
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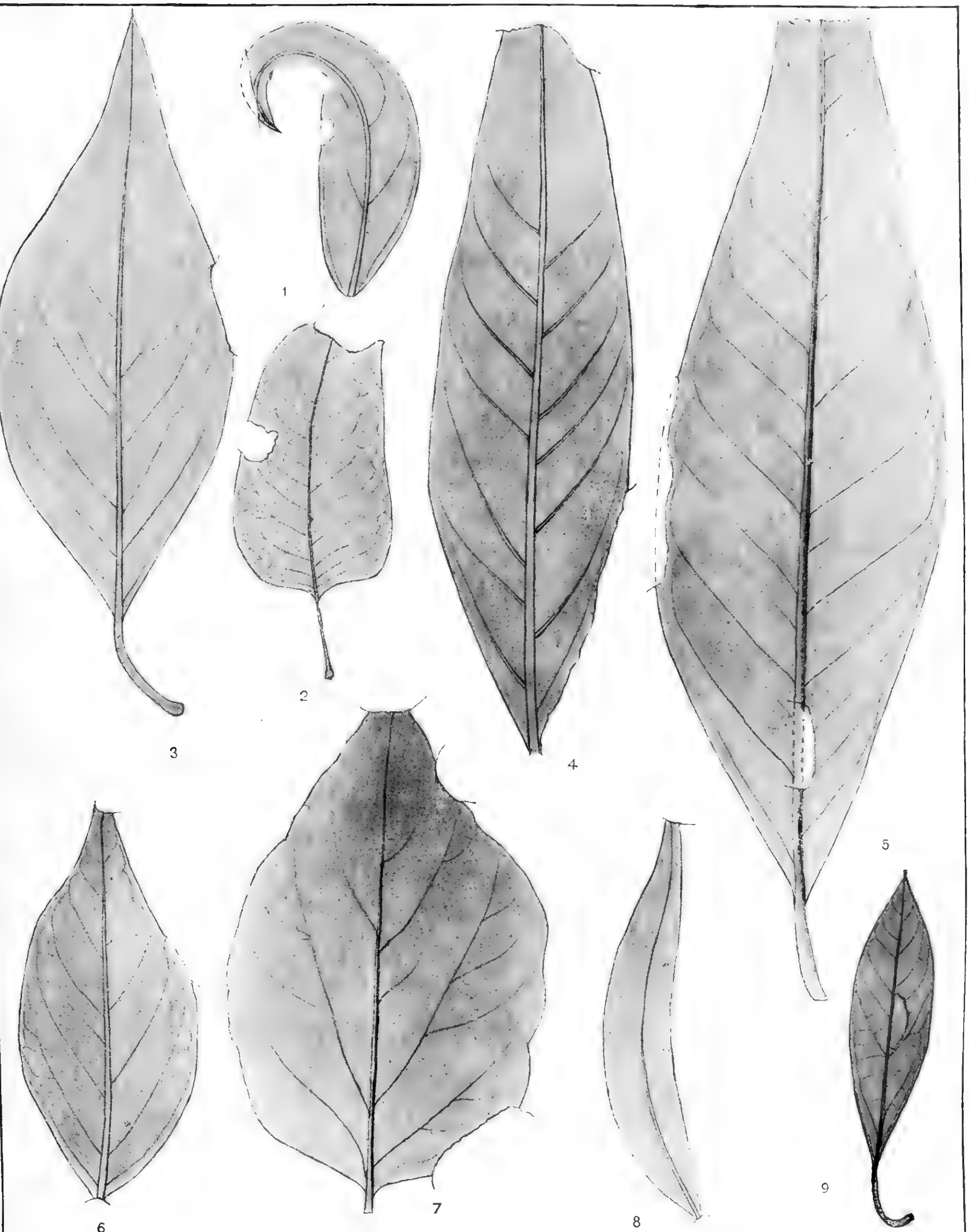
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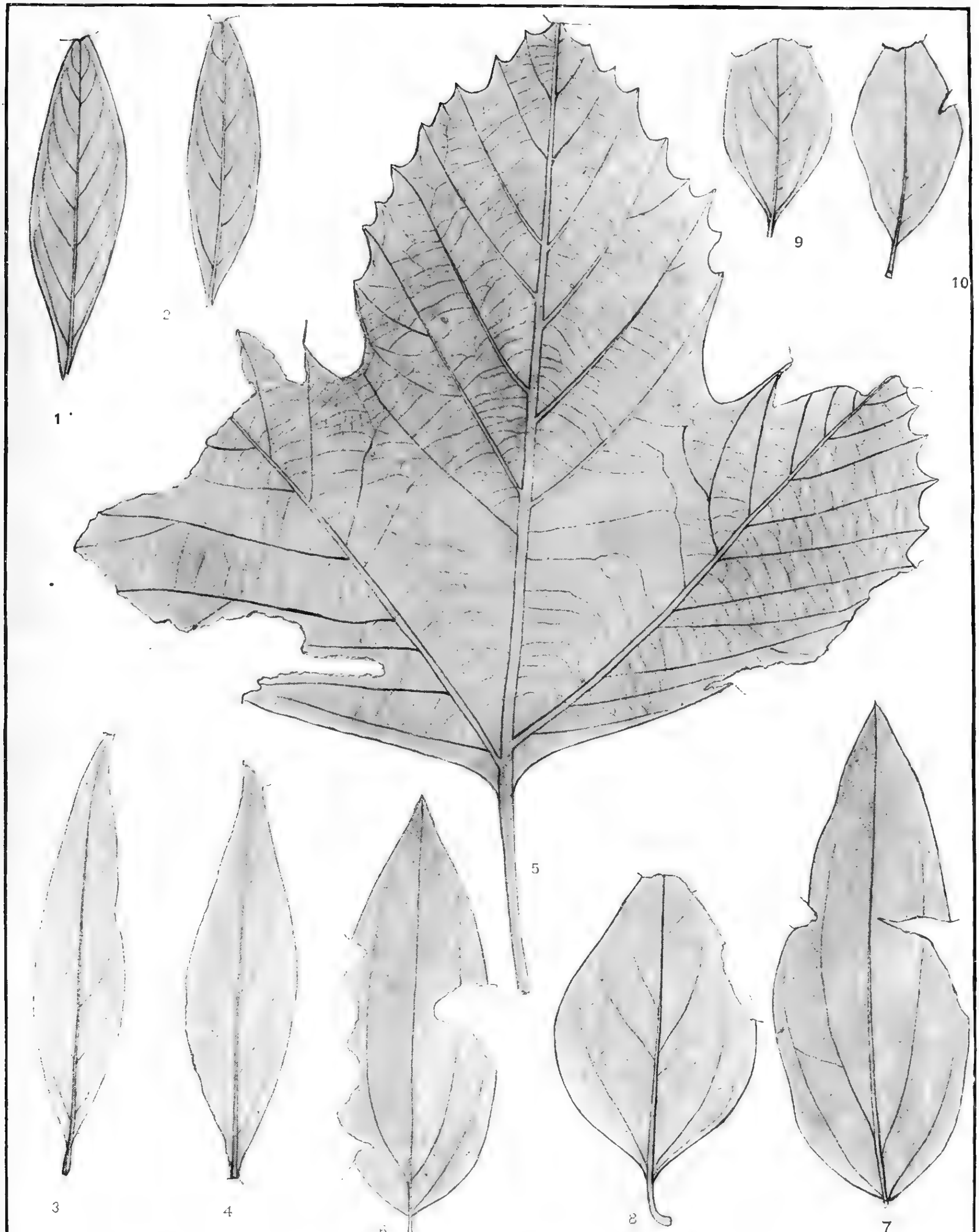
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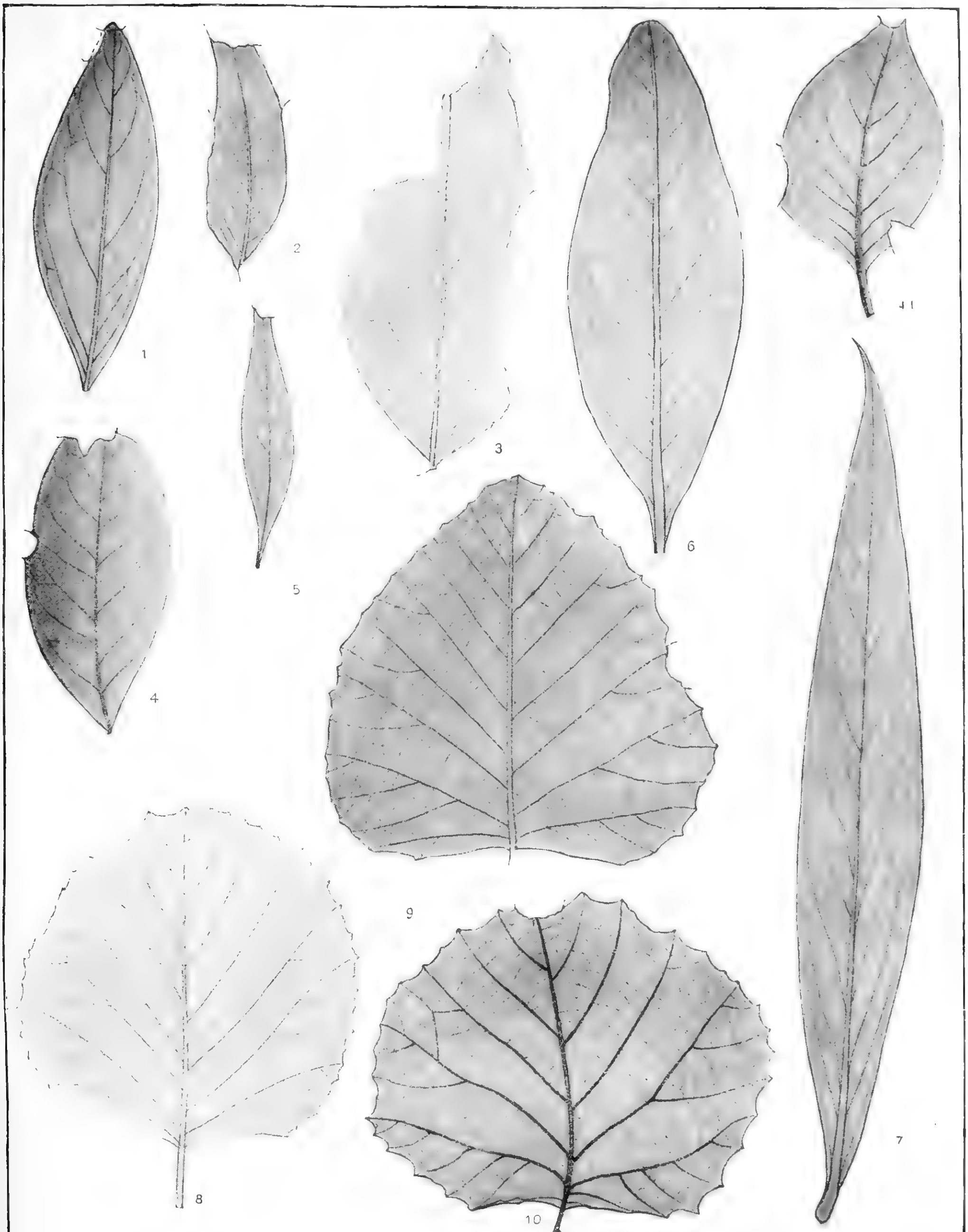
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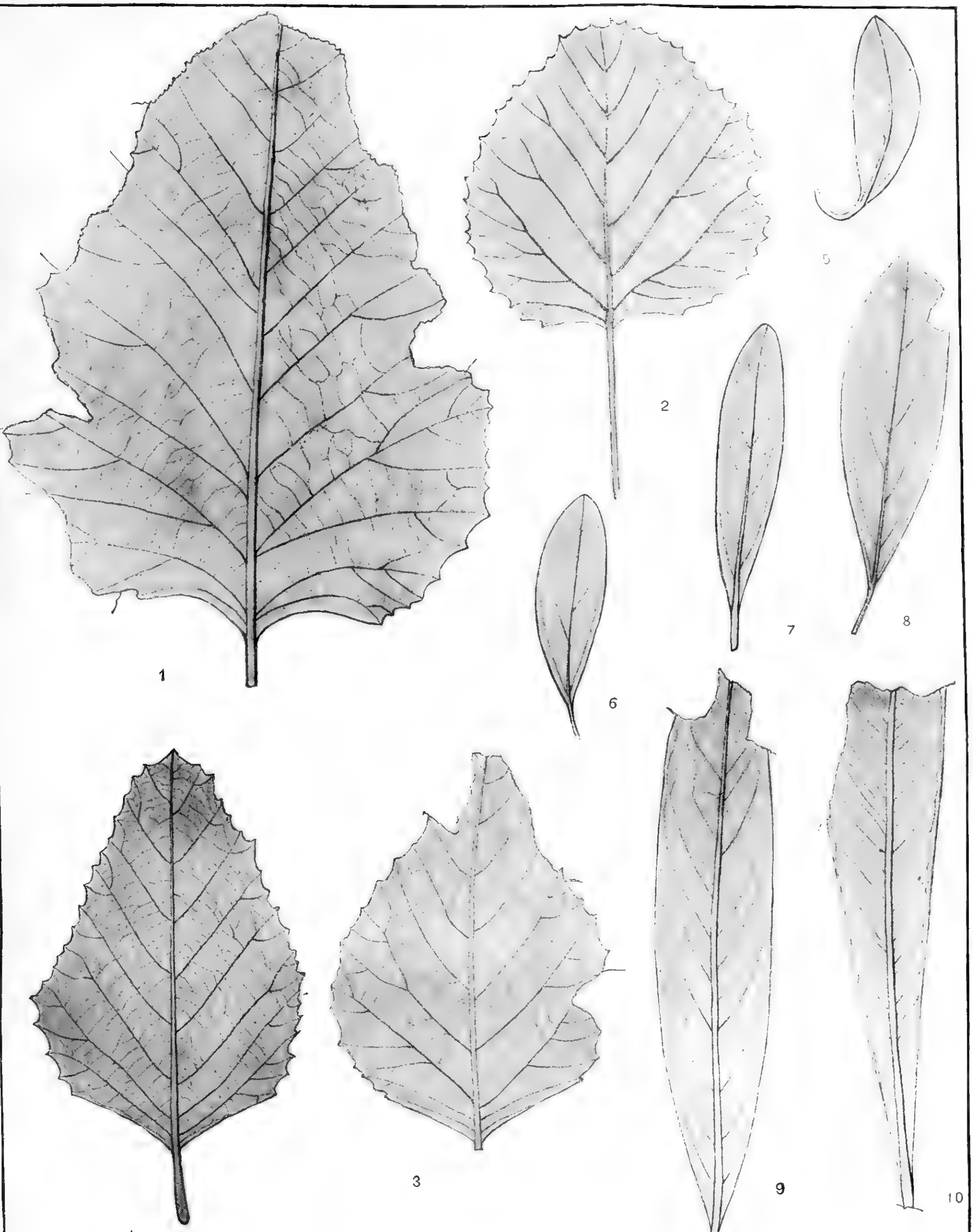
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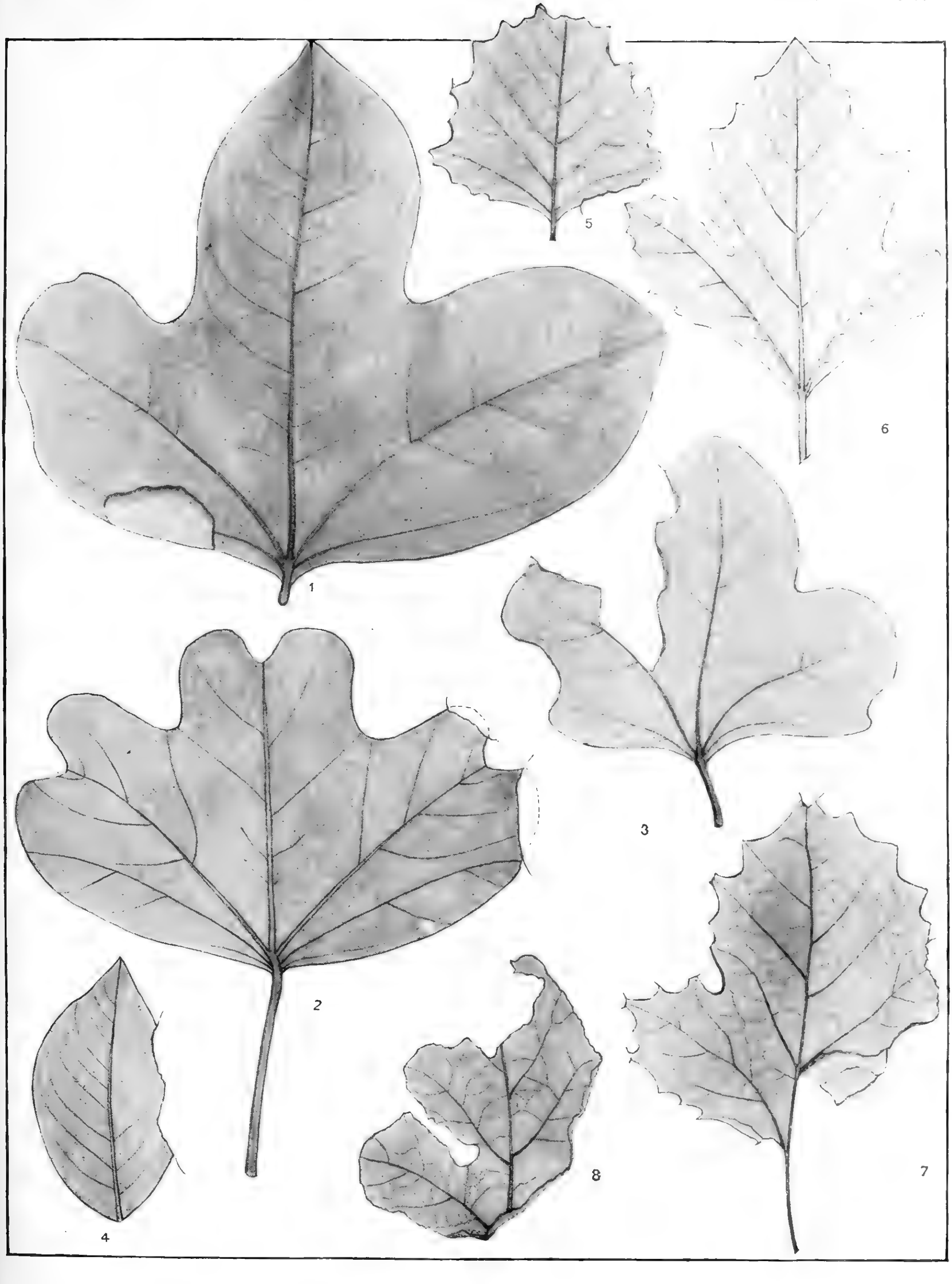

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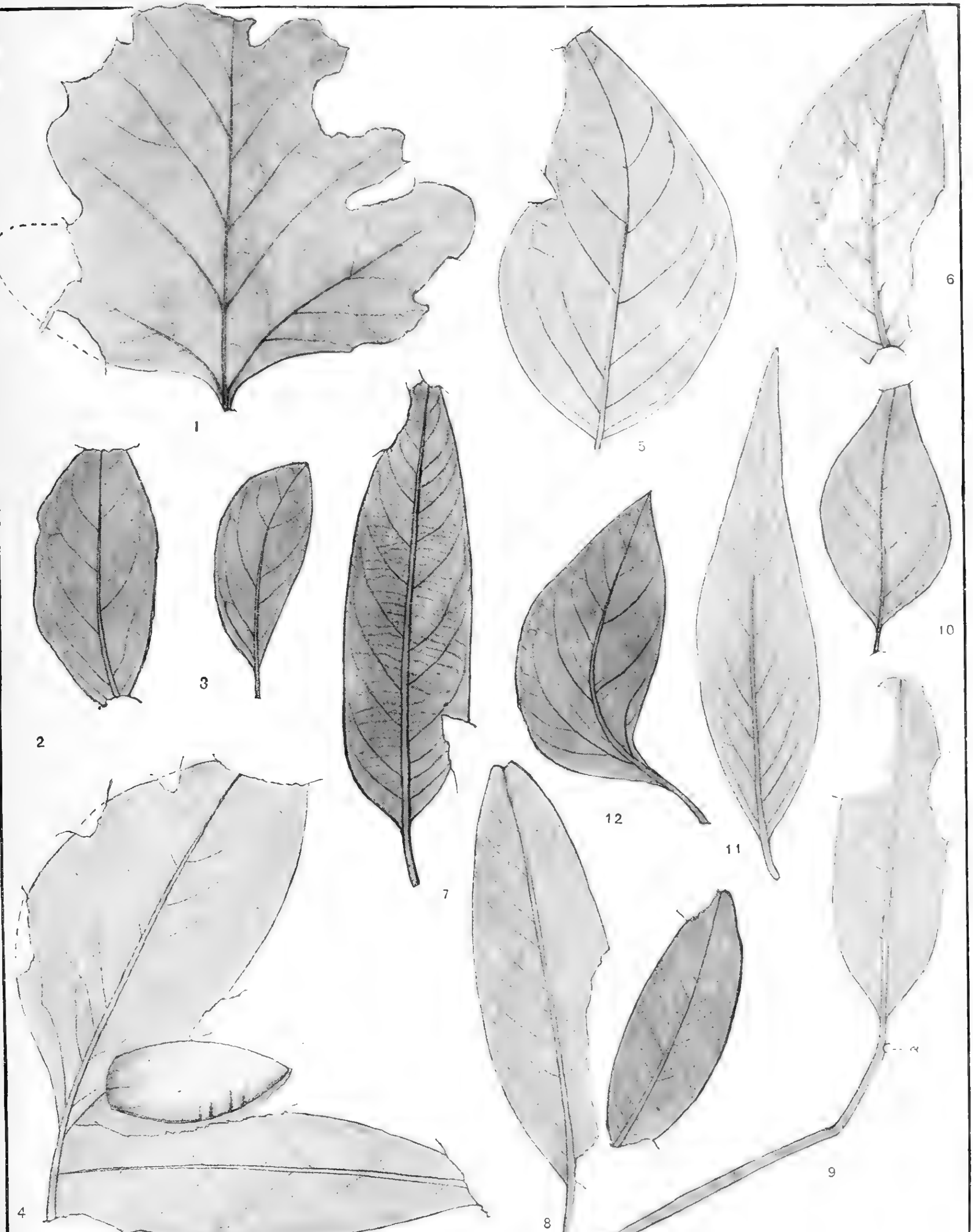
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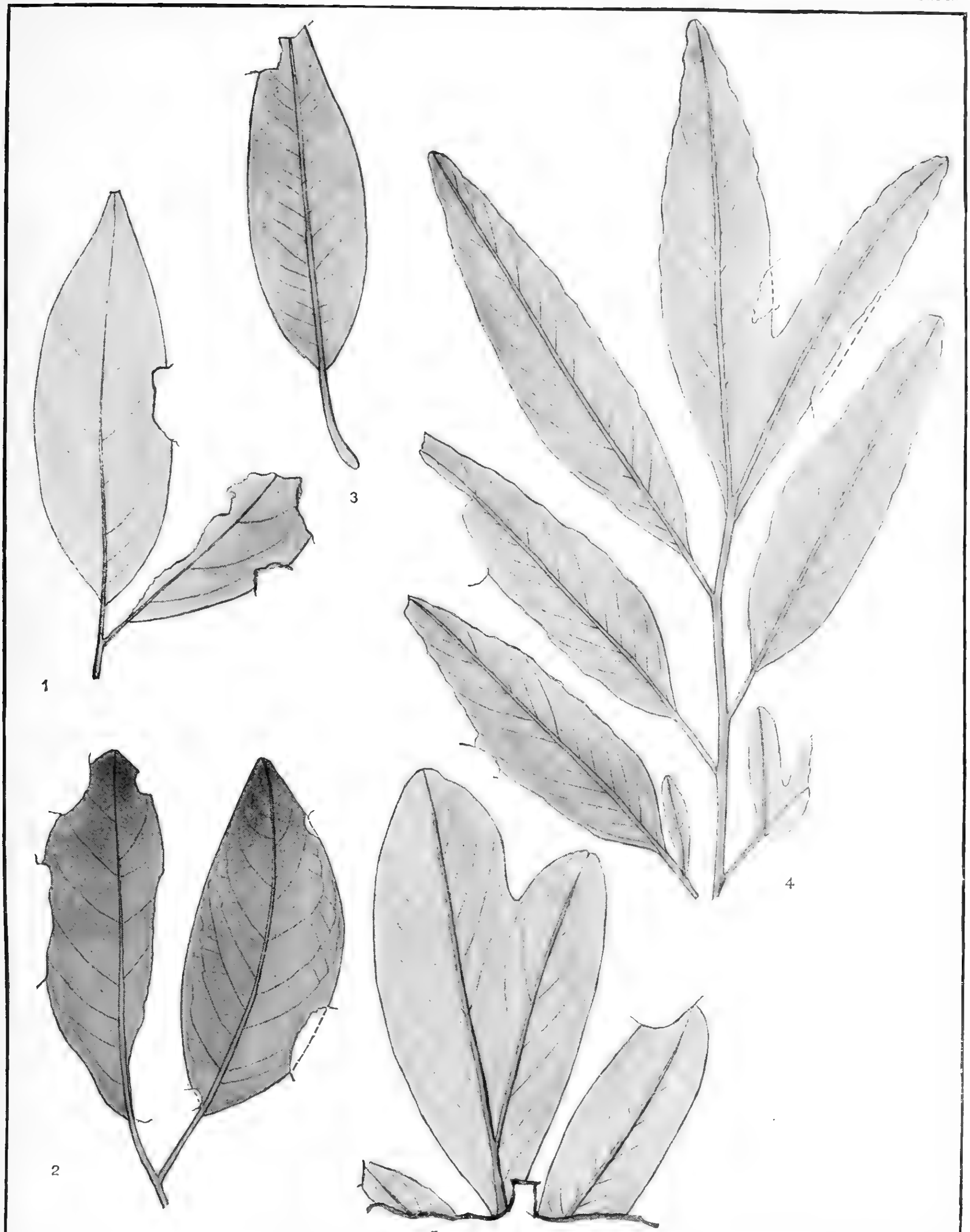
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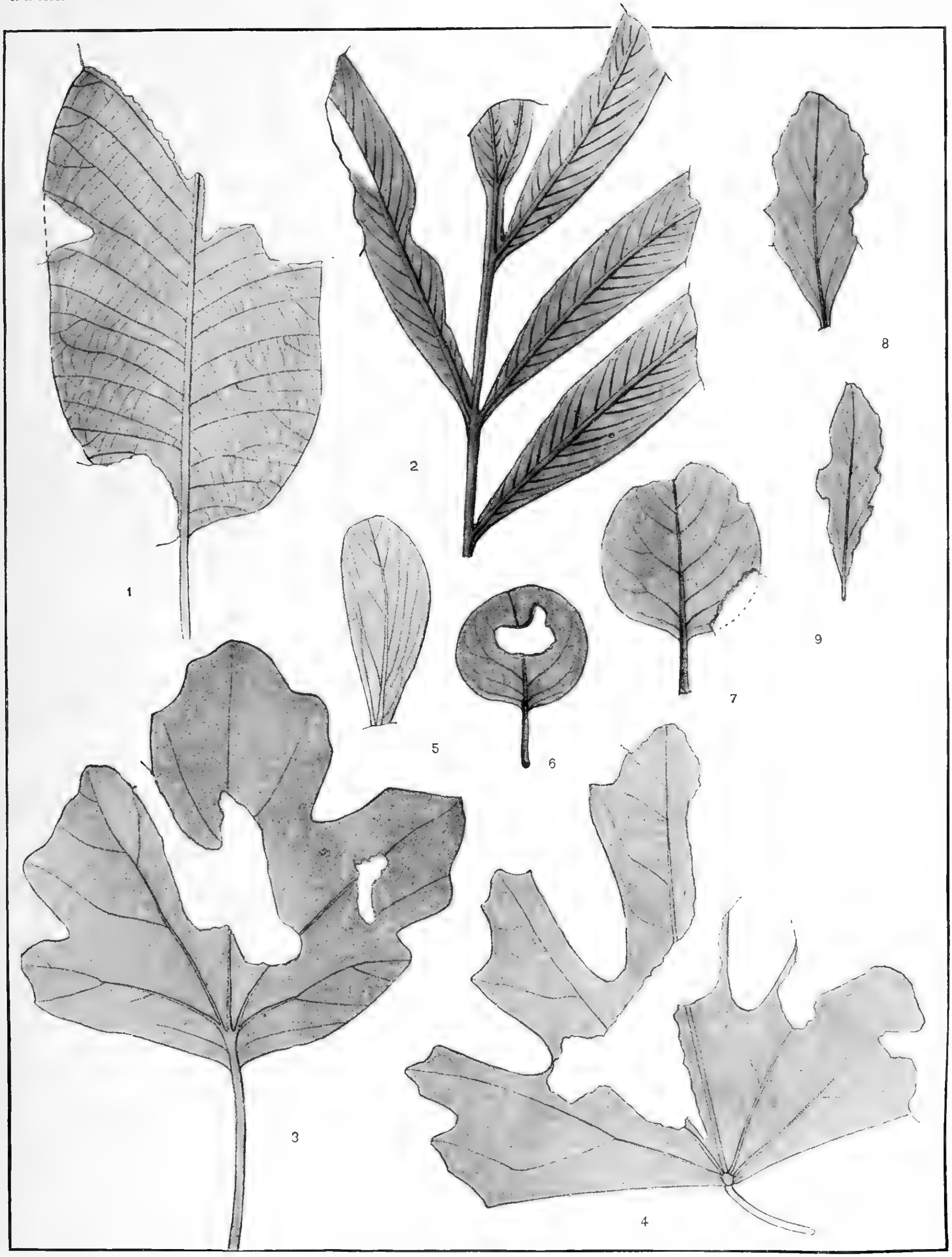
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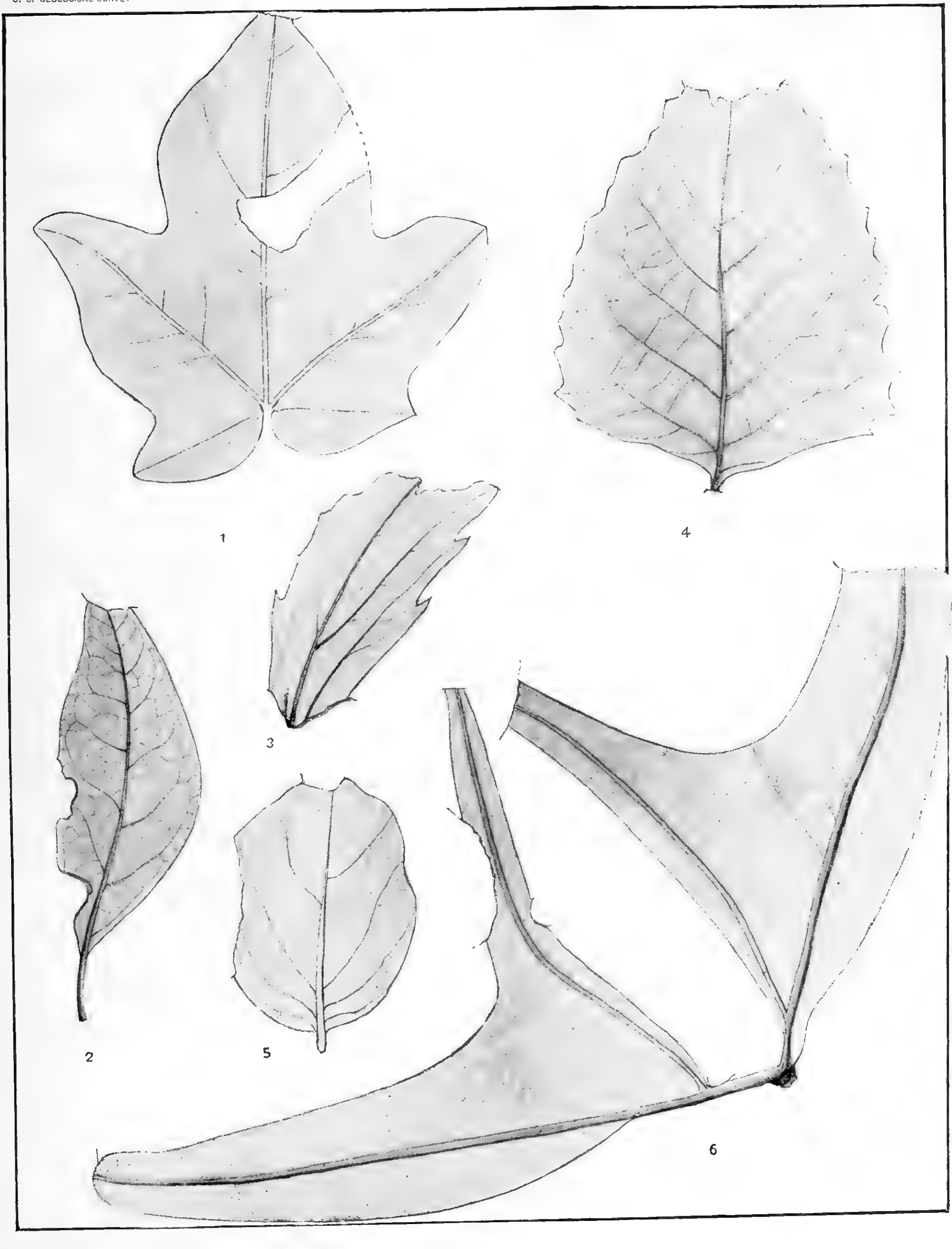
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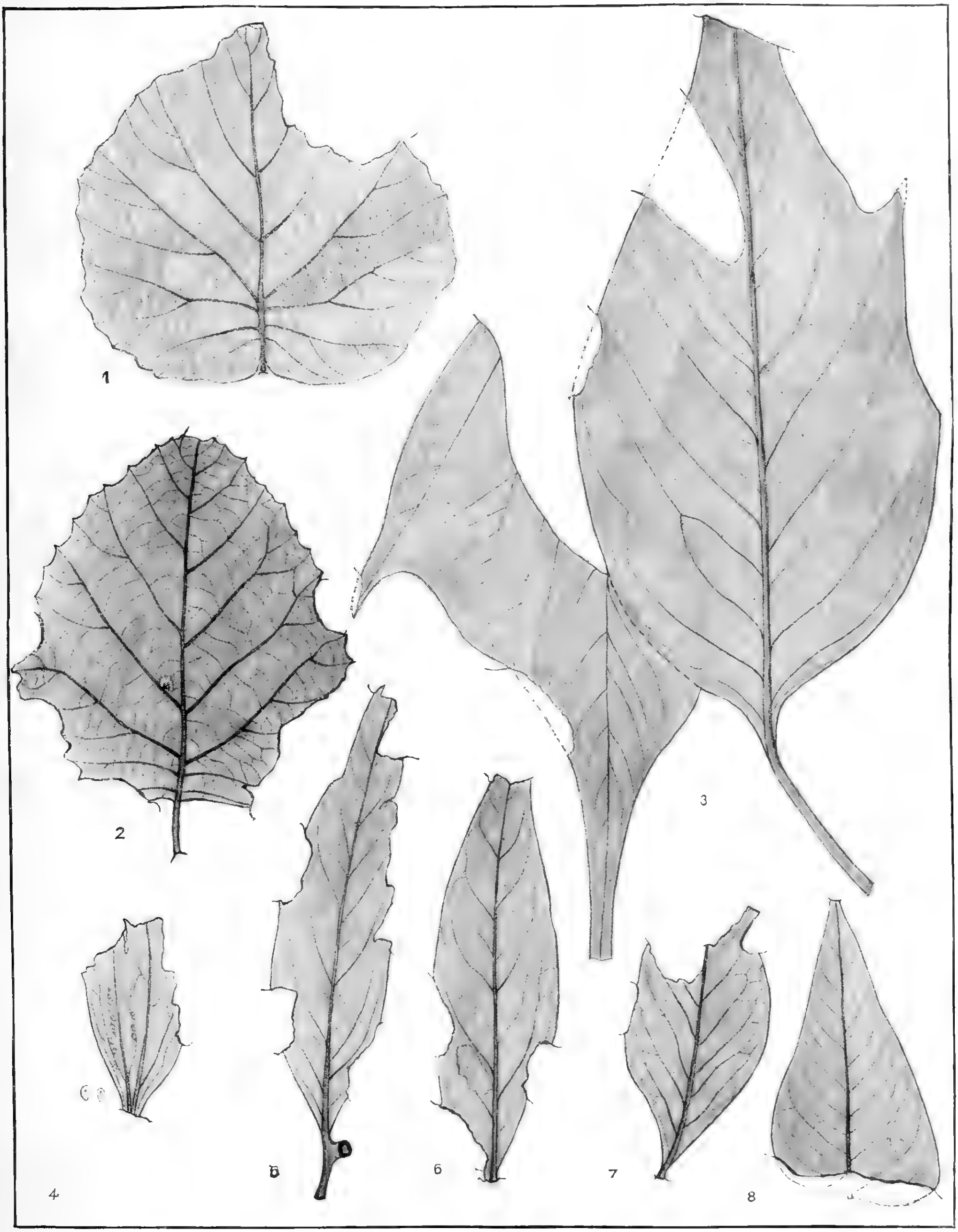
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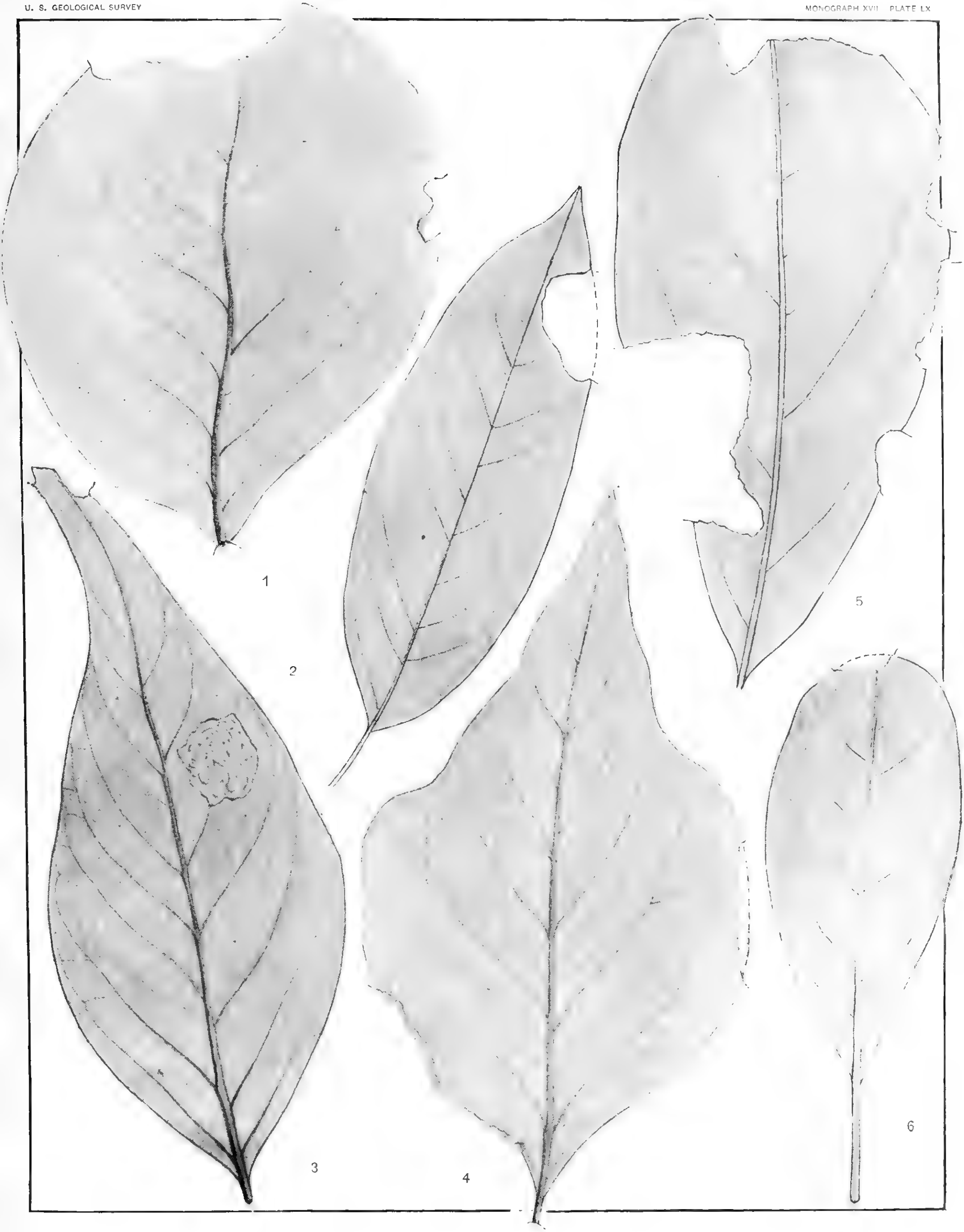
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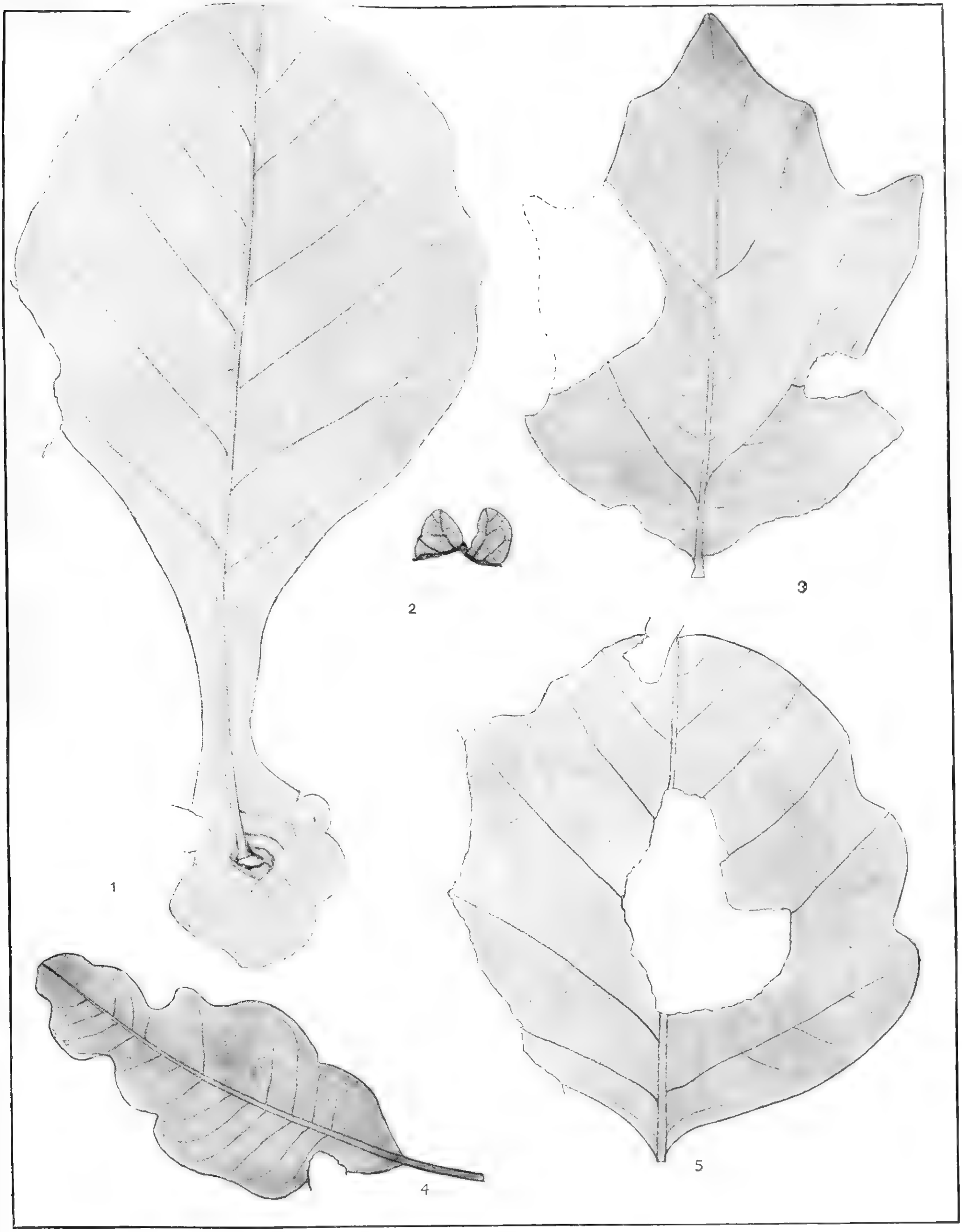
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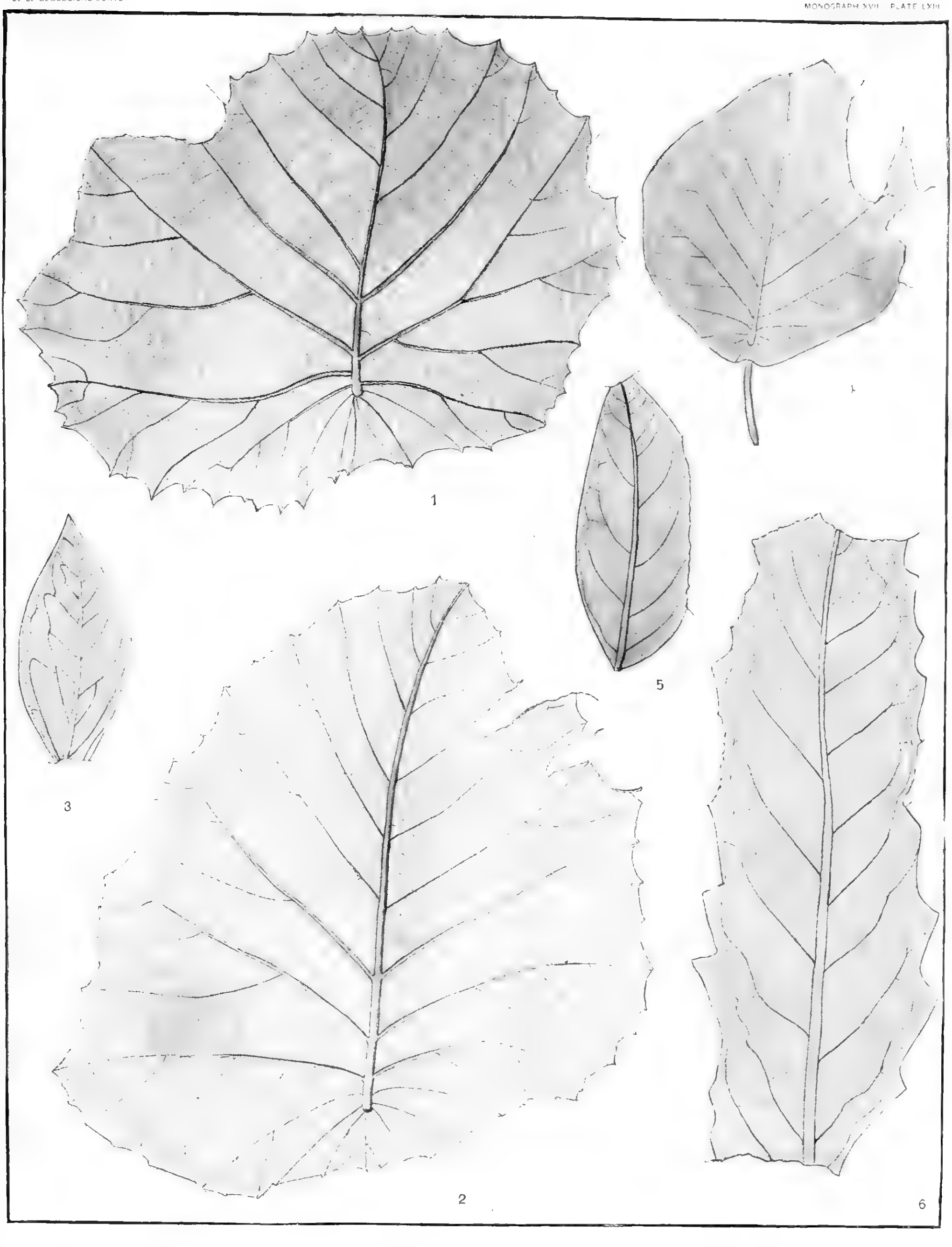
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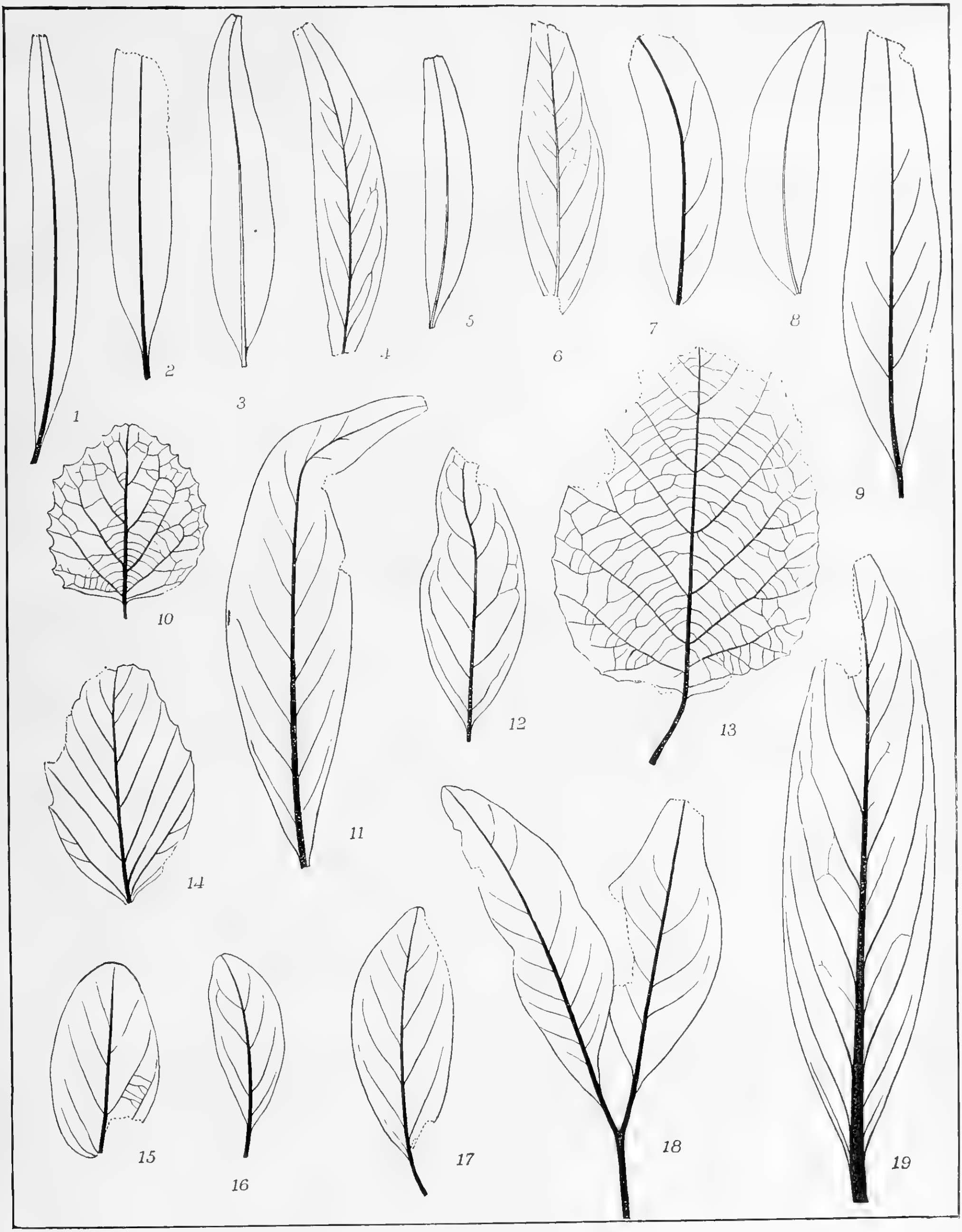
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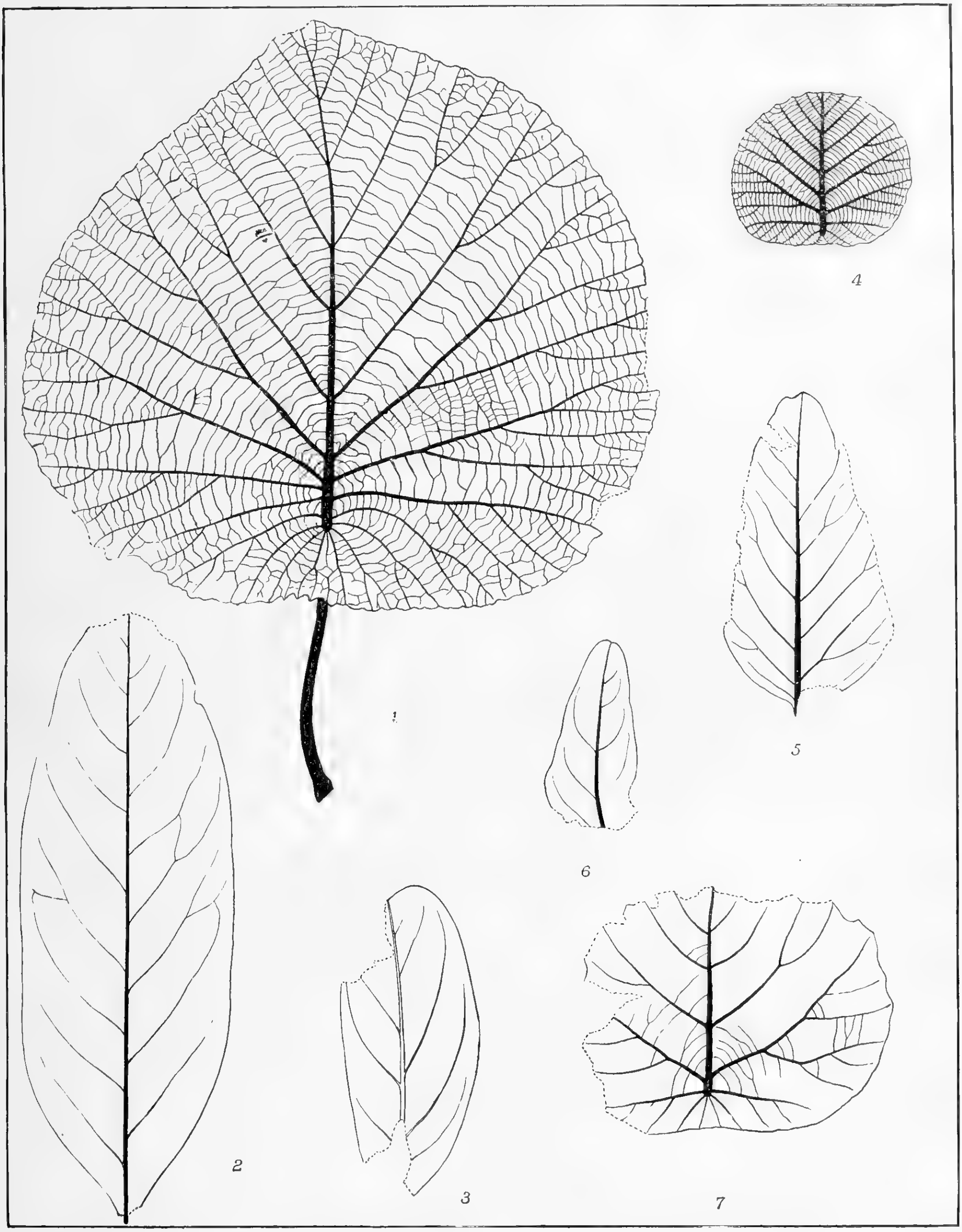
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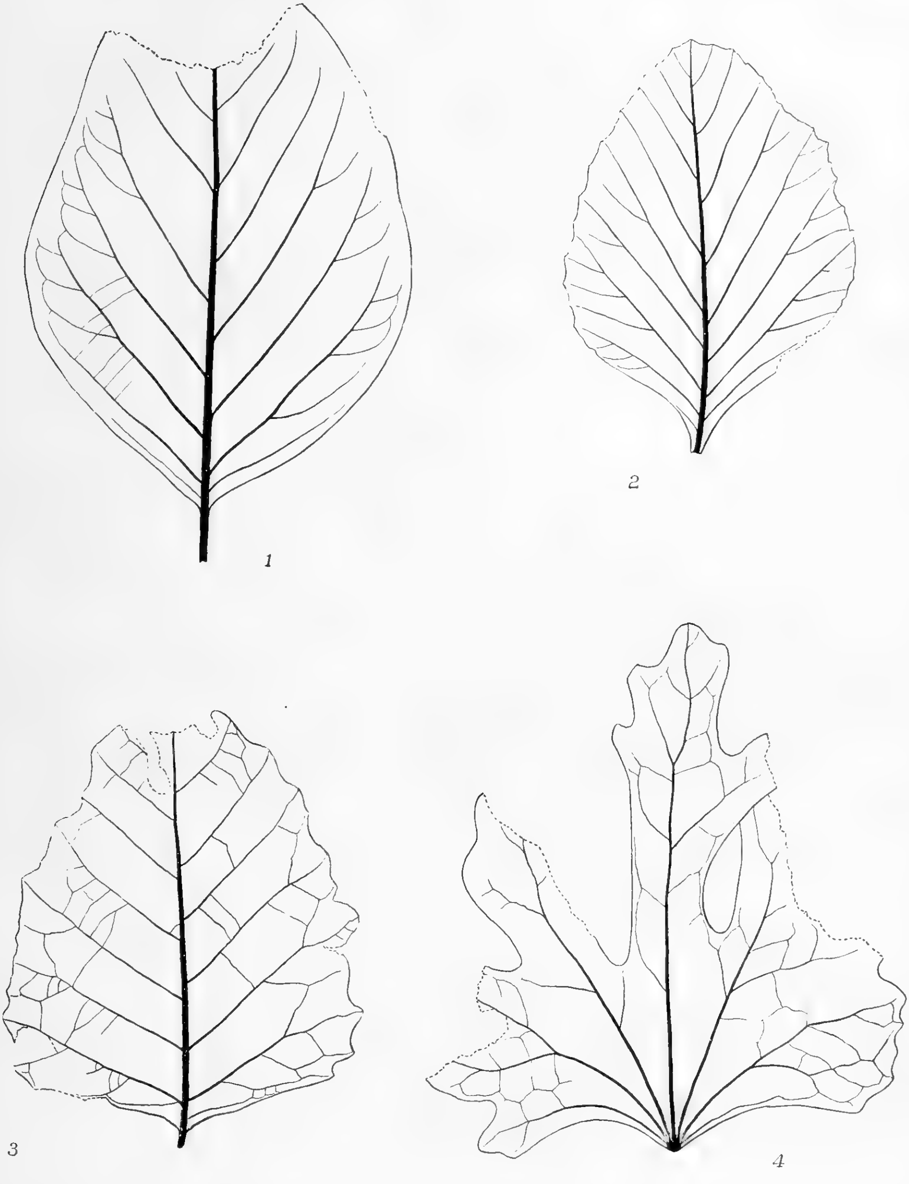

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